Juvenile Chinook Production in the Cowichan River, 1998

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ABSTRACT

Nagtegaal, D.A. ,C.J. Hillier, and E.W. Carter. 1999. A preliminary report on juvenile chinook production in the Cowichan River, 1998. Can Manuscr. Rep. Fish. Aquat. Sci. 2471: 32 p.

In 1991, Fisheries and Oceans Canada (DFO), Pacific Biological Station began a study of juvenile chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. The 1998 study is concerned primarily with the enumeration and out-migration timing of naturally-reared chinook juveniles.

The estimated production of naturally-reared chinook juveniles from the 1997 brood year was 1,638,198 (95% Confidence limit 1,376,097 - 1,900,324). There were three distinct peaks in the out-migration of naturally-reared chinook. The first occurred March 15 - 17, the second and largest occurred March 19 - 21 and the final peak occurred March 23 - 28. The release of chinook from the Cowichan River hatchery totalled 262,675. Of these, 160,924 hatchery-reared chinook were released above the trapping site. Trapping results maintain that most hatchery-reared chinook migrate to the Cowichan estuary within one week of release. Interaction between naturally-reared and hatchery-reared chinook juveniles is therefore believed to be limited.

RÉSUMÉ

Nagtegaal, D.A. ,C.J. Hillier, and E.W. Carter. 1999. A preliminary report on juvenile chinook production in the Cowichan River, 1998. Can Manuscr. Rep. Fish. Aquat. Sci. 2471: 32 p.

En 1991, on a entrepris, à la Station biologique du Pacifique de Pêches et Océans Canada (MPO), une étude sur la productivité du quinnat juvénile (*Oncorhynchus tshawytscha*) dans la rivière Cowichan. L'étude de 1998 est principalement centrée sur le dénombrement et la période de dévalaison des quinnats juvéniles sauvages.

La production estimée de quinnats juvéniles sauvages dans l'année de reproduction 1997 était de 1 638 198 individus (limite de confiance à 95 % : 1 376 097 - 1 900 324). On a observé trois pics distincts dans la dévalaison des quinnats sauvages : le premier du 15 au 17 mars; le deuxième, et le plus important, du 19 au 21 mars; et le dernier du 23 au 28 mars. L'écloserie de la Cowichan a lâché en tout 262 675 quinnats. De ce nombre, 160 924 individus ont été lâchés en amont du site de capture. Les résultats de la capture ont montré que la plupart des quinnats d'écloserie atteignent l'estuaire de la Cowichan dans la semaine qui suit leur lâcher. On pense donc que l'interaction entre les quinnats juvéniles sauvages et les quinnats juvéniles d'écloserie est limitée.

INTRODUCTION

Situated in southeastern Vancouver Island, the Cowichan watershed is one of the most important salmonid producing systems draining into the Strait of Georgia (Candy et al. 1995). Chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), steelhead (*O. mykiss*), cutthroat (*O. clarki*), as well as brown trout (*Salmo trutta*) and dolly varden (*Salmo malma*) spend periods of their life cycle or reside in this system. Historically, the chinook in this system have played an important role in the recreational, aboriginal, and commercial fisheries (Neave, 1949). Since 1958 the discharge of the Cowichan River has been controlled by a weir located at the outlet of Lake Cowichan, approximately 50 km upstream from the mouth of Cowichan River (Burns et al. 1988). There have been periods of perceived salmonid population decline that have led to numerous studies (Lister et al. 1971; Candy et al. 1995; Nagtegaal et al. 1994-98).

Recent years have shown a dramatic decrease in the abundance of chinook throughout BC waters. The late 1970's were characterized by peak harvest rates of approximately 750,000 pieces. In the 1980's these rates dropped to numbers less than 25% of their former abundance (Argue et al. 1983).

For this reason, many stock rebuilding initiatives were implemented. In 1979, the Cowichan River Hatchery initiated a chinook enhancement program. Production began with a modest output of less than 70,000 chinook fry and grew to peak production of 3,000,000 smolts (Candy et al. 1996). The hatchery's 1997 brood stock collection was not very successful. High water levels made it difficult to obtain adults and, consequently, the hatchery only produced approximately 262,675 chinook smolts (D. Millerd, Cowichan River community economic development hatchery manager, P.O. Box 880, Duncan, B.C., pers. comm.).

As in previous years, a portion of these hatchery produced chinook were coded-wire tagged. Fisheries managers rely heavily on the information provided by the tagged salmonids to evaluate the strategies for each hatchery program. The data from tag recoveries also provides key information regarding stock migration, harvest rates, and a measure of enhanced contribution to the stock (Nagtegaal et al. 1998).

In 1985, a chinook rebuilding strategy in conjunction with the Pacific Salmon Treaty, led to the Cowichan's inclusion into a naturally spawning chinook study. Along with the Nanaimo and Squamish River stocks, the Cowichan chinook stock was chosen as an escapement indicator to stop the perceived decline of Lower Strait of Georgia chinook and monitor the rebuilding of escapement into these systems (Nagtegaal et al. 1998). The accurate enumeration of chinook migrants is also an important resource management tool. For this reason the results of this ongoing study can be used to assess enhancement strategies; harvest management practices; as well as investigate possible interactions between hatchery-chinook and naturally-reared chinook.

For the purposes of this study, we refer to hatchery fish as those that were spawned and reared in the hatchery environment regardless of parental origin, and naturally-reared fish as those that spawned and reared in the river environment. The naturally-reared juvenile chinook of Cowichan River are considered to be the "ocean-type". This means that they usually migrate to sea within three months of emergence (Healey 1991). Lister et al. (1971) subdivided the Cowichan chinook migrants into two distinct groups. The 'early group' comprises the majority of the migrants and consists mainly of newly emerged fry with an average length of approximately 42 mm. The 'early group' migrates to the estuary in March and April. The 'late group' as described by Lister are larger with lengths averaging over 55 mm. This group may rear in the river system for up to 90 days before migrating to the estuary in May and June. This 'late group' may account for approximately 15% of the total juvenile chinook population (Nagtegaal et al. 1998).

METHODS

STUDY SITE DESCRIPTION

The Cowichan River begins at the Lake Cowichan weir and drains the mountainous slopes of the Vancouver Island range with a watershed area of 840 km^2 (Candy et al. 1995). Approximately 40 km north of Victoria, the Cowichan River flows eastward through the City of Duncan, and carries a mean annual discharge of 55 m^3/s (Nagtegaal et al. 1995). Skutz Falls, located 18 km downstream of Lake Cowichan, is a partial obstruction to the upstream migration of chinook spawners. In 1956 a fishway was built to help alleviate this problem (Lister et al. 1971). The Cowichan chinook spawn primarily in the mainstem, above Skutz Falls (Nagtegaal et al. 1997).

The rotary trap was placed at the City of Duncan old pumphouse site (Fig. 1). It was assumed that virtually all chinook spawning occurred above this point. Sites 7B and 7F were used exclusively for this study. Site 7B is a wider section of Cowichan River with canyon walls on one side. Site 7F is located in a narrower portion of the river just upstream of 7B and was used only when low discharge and flow rates interfered with the ability of the trap to catch fish.

FISH CAPTURE

An auger or rotary screw trap, 2.4 m in diameter was used to trap juveniles migrating downstream to the Cowichan Estuary. Fish passing through the cone were collected in a live box. In operation from February 26 to May 15, the trap was held in place by a galvanized steel cable which secured the trap at site 7B (the lower pumphouse site). When flows became too low (May 1), the trap was moved upstream to site 7F (the upper pumphouse site). On Sunday, Tuesday, and Thursday evenings, the trap was set at 1900 hrs and fished continuously until 0700 hrs the following morning at which time the trapped fish were removed. During trap efficiency tests, trapping occurred continuously over 24 hour periods. When this occurred the trap was checked at both 0700 and 1900 hours.

All fish captured were enumerated by species and recorded by time period and capture date. Chinook migrants were identified as hatchery or naturally-reared, based on identifiable physical characteristics (size, absence or presence of an adipose fin). Coho were recorded as either fry, one or two year old smolts. Biophysical conditions (water temperature, flow rates, clarity, and weather conditions) were also recorded.

ABUNDANCE ESTIMATES

Trap efficiency information, using the mark - recapture of Bismarck brown stained juvenile fish (Ward and Verhoeven 1963), was used to expand the trap catch to estimate total numbers migrating past the trap site. Juvenile chinook and chum were stained, and then released approximately 500 m upstream from the trap site. The number of stained fish recaptured from continuous trapping over the next three to four days was recorded.

The proportion of marked fish recaptured was used to expand the unmarked fish catch and estimate the total number of fish. Mark - recapture estimates were done on a biweekly basis using chinook until captured fish became too few to complete the process. At this point chum were used in the mark - recapture estimates.

Trap efficiency was estimated using:

$$Eij = Rij \Big/ Mij$$

where:

E is the estimated trap efficiency at site i and sampling week 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 traps site migrate downstream past the trap,
iii. marked fish behave the same as unmarked fish, and
iv. all recaptured fish were counted.

The total number of fish was estimated by:

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

where:

N is the estimated number of marked fish.
U is the catch of unmarked fish in the trap.

Estimates of daily fish migration were obtained by taking the mean of the days when the trap was in operation to fill in the non-fishing days. For example, when the trap was fishing on Monday and Wednesday, but not on Tuesday the mean catch for the fishing days was inserted for the non-fishing days. Twenty-four hour estimates were extrapolated for the parts of the day when the trap was not in operation. The total abundance estimate was taken from the sum of the daily catch estimates for the duration of the study (Nagtegaal et al. 1997).

The adjusted Petersen estimate (Ricker 1975) was used to obtain confidence limits of trap efficiency. Since there is added uncertainty from using biweekly trap efficiencies, interpolation of unsampled days, and extrapolation for unsampled parts of the day, the confidence limits were considered to be minimum (Nagtegaal et al. 1995; Candy et al. 1996).

GROWTH

Observations on growth for naturally-reared chinook were obtained by collecting samples from each catch of the rotary trap. Thirty chinook migrants were measured to the nearest mm fork length, and weight was recorded to the nearest one hundredth of a gram.

At the Cowichan River hatchery between 30 to 50 chinook were sampled for each rearing strategy prior to release. Due to the hatchery's lower broodstock captures, and subsequent low fry production, sampling the hatchery component of this study was greatly reduced.

RESULTS

BIOPHYSICAL CONDITIONS

During the study period the discharge of the Cowichan River decreased steadily from 110 m^3/s on February 26 (with a February mean discharge of 128 m^3/s) to 9.51 m^3/s on May 19. The mean discharge for March was 69.6 m^3/s; for April 26.4 m^3/s; and for May 11.1 m^3/s. Flow rates decreased from a high of 1.64 m/s to a low of 0.39 m/s. Water temperatures increased from 5^0C to 14^0C (Fig. 2).

On one occasion, large organic debris accumulated in front of the trap (March 10). The total catch on this day was much lower than trap catch prior to or following this date. Therefore, it is believed that the build up of organic materials on this day interfered with the ability of the trap to catch fish. On a regular basis, there was a build up of small organic debris in the trap. However, when this occurred there was no noticeable difference in the fishing efficiency of the rotary trap.

Water clarity at the trapping site was recorded as clear or cloudy. For the first three weeks of the study it was recorded as cloudy. From March 18 until the end of the study the water was consistently clear with only three exceptions (two in mid March and one in mid April). During the time of the study there were only three days where rain was recorded (Table 1).

MIGRATION TIMING

At the pumphouse 25,983 naturally-reared and 1,911 hatchery chinook juveniles were caught in the auger trap (Table 1). Downstream movement of naturally-reared chinook was observed from February 26 (983) to May 19 (10). The downstream movement of hatchery chinook was observed from April 10 (124) to May 19 (420). It was assumed that the hatchery fish released in the upper river would have reached the trapping site within approximately one week of their release date (Nagtegaal et al. 1998). Naturally-reared chinook migration peaked in mid – March (Fig. 3). It must be noted, however, the first catch of naturally-reared chinook in the rotary trap was substantial (983) relative to previous years and indicated that downstream migration had begun earlier.

HATCHERY RELEASES

Cowichan River Hatchery had two releases 30 km above the trapping site during the study. There was overlap in the size range between the hatchery fish and the naturally-reared fish during the first release.

Prior to the second hatchery release, the sampled size of naturally-reared fish was still less than the hatchery fish. However, with the migration of the '90-day' chinook smolts (Lister et al. 1971) there may have been some overlap in size making it difficult to distinguish larger naturally-reared fish from smaller hatchery-reared chinook, especially in the absence of adipose clips.

A total of approximately 160,924 hatchery-reared chinook were released above the trapping site (Table 2). Of these fish 150,747 received coded wire tags (CWT). The early release group (approximately 76,117 fish) was released in the upper Cowichan River on April 9 at the Road pool site. The late release (84,807) occurred on May 12, also at the Road Pool site. In total the rotary trap caught 885 adipose-clipped hatchery-reared fish. The lake pen release strategy was not used this year.

TRAP EFFICIENCIES AND ABUNDANCE

At the lower pumphouse site (7B), the mean trap efficiency (Table 3) for naturally-reared chinook was calculated to be 3.34% (Fig. 4). After April 9, 1998, capture numbers for naturally-reared chinook were so low that chum were used for the two subsequent efficiency tests. The mean efficiency for all tests was determined to be 3.21%. At the upper pumphouse site efficiency tests were not conducted. For this reason efficiency data obtained from this site in the 1996 study were used.

We estimated the total number of naturally-reared chinook migrants in Cowichan River to be 1,638,211 (95% CL: 1,376,097 – 1,900,324) and the number of hatchery-reared chinook to be 170,057 (95% CL: 99,289 – 271,155). Reports from the Cowichan River Hatchery indicated that a total of 160,924 were released above the trapping site. It should be noted that the hatchery estimate was incomplete as a release occurred only seven days prior to the end of our study, and the last sampling day recorded 420 hatchery smolts.

DIEL MIGRATION

This year's study did not include a continuous 24-hour trapping component to determine diel migration. For this reason all assumptions of diel movement were obtained from previous studies. The only daytime trapping occurred in conjunction with the trap efficiency tests. These scanty results indicated that the majority of chinook migrants were caught in the over night sampling, rather than the daytime hours. Nagtegaal et al. (1997) indicated that more extensive 24-hour trapping sessions must be completed in order to obtain a more confident estimation of diel migration patterns.

GROWTH

During the study period, growth rates (mean length and weight) of naturally-reared chinook juveniles changed little until May (Appendix 1). Mean length was consistently recorded at approximately 40 mm and mean weight at .50 - .55 gm. The early release hatchery fish were much larger, with a mean length of 69.7 mm and weight of 3.7 gm (Appendix 2). This size difference should have made them easily distinguishable from the naturally-reared chinook.

Toward the end of the study, the size of naturally-reared fish showed a slight length and weight increase, however, subsample sizes were much smaller than in previous sampling (N= 1 to 15). The late hatchery release fish had a mean length of 82.3 mm and a weight of 6.3 gm (Fig. 5). The lack of an experienced crew may have led to some chinook juveniles being incorrectly identified.

CODED WIRE TAG RECOVERIES

During the study, 885 hatchery chinook juveniles out of the total hatchery capture (1911) were identified as being adipose-clipped (coded wire tagged). This number represents 46% of the total number of hatchery chinook caught in the trap, or .59% of the total number of coded-wire tagged hatchery releases.

DISCUSSION

ABUNDANCE ESTIMATES

Approximately 1.64 million naturally-reared chinook migrated from Cowichan River in 1998 (95% CL: 1,376,097 - 1,900,324). This estimate did not take into consideration the migration of chinook prior to the installation of the rotary trap. Nor did this study take into consideration any migration of chinook smolts after the study ended. It has been reported (Lister et al. 1971) that there is a later migration of juveniles that peaks after May.

This late migration of chinook may have been observed in the Cowichan Lake coho study conducted on the Cowichan River during May/June. Two kilometers downstream of the road pool a large number of chinook smolts were captured in a modified fyke net (Table 4). These fish were larger and may represent the later migratory run or they may be stragglers from the late hatchery release on May 13.

It is interesting to note that these larger chinook smolts were also spotted in Meade Creek, an intermittent Cowichan Lake tributary, during fry salvage efforts by members of the Lake Cowichan Salmonid Enhancement Society in June. In May/June, chinook fry were also identified in Nixon Creek, another intermittent Cowichan Lake tributary. Since the lake pen hatchery release strategy was not used this year it is unlikely that these fish were of hatchery origin. This could not be confirmed since adipose-clipped or coded-wire tagged juveniles were not recovered.

Neave (1949) in his report on the Cowichan River discusses a spring run of chinook that spawned primarily around the Cowichan Lake tributaries. He postulated that these spring run fish were near extinct in his time. Whether these populations of chinook are remnants of a spring run or directly related to the lake pen release strategy is unknown.

Chinook abundance estimates using the Bismarck Brown stain to calculate trap efficiency may be biased low. The assumption that stained fish have the same capture rate as unmarked migrant chinook may be untrue. The stained fish have endured more handling and stress associated with the marking process. Therefore, swimming ability and behavior of these fish may be affected and translate into lower recapture rates (Nagtegaal et al. 1997). According to Frith et al. (1995), not all released marked fish are available for recapture. Some fish are lost to predation, disease or residualization.

Water turbidity or clarity would likely affect trap avoidance by migrating chinook. Increased turbidity may decrease the ability of the migrants to avoid capture. Clarity combined with lower flow rates may have the opposite effect, increasing the ability of migrants to avoid capture. Excluding the first three weeks of the study, the water was consistently clear. Water temperatures rose from 6^0C to 14^0C during the course of the study.

Flow rates during recapture periods ranged from a high of 1.25 m/s on March 4 to a low of 0.43 m/s on April 15. April 29 showed a slight increase to 0.65 m/s. Low flow rates and other discharge dynamics, in combination with the cone rotation, may affect the efficiency of the trap (Frith et al. 1995).

For this study it was assumed that trap efficiencies for naturally-reared and hatchery-reared chinook were different. The efficiency information for naturally-reared chinook was obtained through Bismarck Brown efficiency tests conducted through the course of the study. For hatchery-reared chinook, data from the 1995 study were used.

Efficiency tests from other studies (Thedinga et al. 1994, Roper and Scarnecchia 1996) indicate that there are considerable differences in trap efficiencies between species, flow rates and fish size. Biophysical factors such as low flow and clarity along with the use of trap efficiencies for hatchery chinook from previous years may partially account for the low bias in this year's estimate. Wetherall (1970) submitted that higher survival rates of migrants were observed with larger fish and high flows (discharges), while fingerling in stream discharges less than 20 m^3/s had lower survival rates.

Trap efficiencies may be affected by the stream characteristics in which the trap is placed. Site 7B is located in a riffle or run section of the pumphouse site, while site 7E is located in an upstream pool. Roper and Scarnecchi (1996) stated that hatchery-reared fish were often able to avoid a trap in a low velocity riffle area, however, when the trap was positioned at the head of a pool they were often caught.

According to Seelbach (1985) and Roper and Scarnecchi (1996), key factors that affect hatchery fish migrations are size and time of outplanting and water velocities. Another possible reason for the low bias is the misidentification of hatchery fish as naturally-reared fish. An inexperienced crew may account for this. It is interesting to note that on the last day of trapping, 420 hatchery-reared chinook smolts were captured, indicating that the migration of the late hatchery release was not over.

EGG TO FRY SURVIVAL

To estimate the egg to fry survival rate, an accurate assessment of adult spawners, the percentage of females in the escapement, the average fecundity, and juvenile outmigration are needed. Adult chinook escapement for 1997 was determined to be 7,525 (Nagtegaal et al. 1998). Natural spawners were estimated at 7,086. The proportion of females was determined to be 54%, or 4,085. The average fecundity from broodstock biosample data was determined to be 3,723. With this information, the total egg production was estimated to be 15,208,455 (Fig. 6).

The estimated abundance of naturally-reared chinook fry was extrapolated to be 1,638,211. The egg to fry survival was therefore estimated to be 10.77% (95% CL: 9.05% - 12.50%). This estimate is comparable to survival rates from previous surveys in 1991 and 1995 (Nagtegaal et al. 1997) and is also comparable to Healey (1991) who reported chinook egg to fry survivals ranging from 8% to 16%.

The differences in survival rates among years may be attributed to many factors ranging from biophysical conditions, chum escapements and spawner distribution (Nagtegaal et al. 1997). Spawner distribution in 1997 was consistent with 1994 and 1995 (most chinook spawning occurred in the middle section of the river) and low chum escapements in recent years seem to have enhanced the egg to fry survival rate (Nagtegaal et al. 1998).

JUVENILE CHINOOK GROWTH

The length - weight sampling during the study showed little increase in average size of naturally-reared chinook until after April 27. Growth information obtained from May 6 to the end of the study is questionable due to smaller subsample sizes. It is unlikely that subsample sizes ranging from 1 to 15 provided accurate population representations.

According to one participant at the trapping site, the identification of naturally-reared versus hatchery chinook became more difficult after the late hatchery release since the length of naturally-reared fish had increased. It is likely that there was an overlap in fish sizes and the incorrect identification of hatchery fish as naturally-reared chinook may have occurred as a result.

JUVENILE CHINOOK INTERACTION

The possibility of interactions between the early naturally-reared chinook (Lister et al. 1971) and hatchery-reared chinook in Cowichan River seems to be limited. Approximately 85% of the naturally-reared chinook head to the estuary upon emergence (Nagtegaal et al. 1997) and the peak migration of these chinook occurred in mid to late March, prior to the first hatchery release on April 9.

The late hatchery release occurred on May 13. By this time the majority of 'early' chinook migrants had already passed the trapping site, and capture rates of these naturally-reared chinook had decreased substantially. Possible interactions between hatchery released chinook and the 'late' larger migrants could occur even if the hatchery fish move quickly to the estuary upon release, as Candy et al. (1996) indicated. The small numbers of hatchery fish released and the assumed small population of 'late' migrants would suggest a very limited possibility of interaction.

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Table 1. Rotary screw trap data at pumphouse location.

Set date	Site	W	Temp	Clarity	Sampling Date	Start Time	CNW	CNH	CNC	CM	COF	CO1	CO2	BB
25-02	7B	2	6C	2	26-02	13:00	983				1	6		
01-03	7B	1	6C	2	02-03	8:00	810			148	6	14		
03-03	7B	1	6C	2	04-03	7:00	941			282	1	13		
04-03	7B	1	5C	2	05-03	8:00	828			411	51	18		5 CNW
05-03	7B	1	6C	2	05-03	19:00	37			20	3	3		
05-03	7B	1	5C	2	06-03	7:00	842			291	23	27		
06-03	7B	1	6C	2	06-03	19:00	57			26	1	1		
07-03	7B	1	5C	2	07-03	7:00	504			240	14	16		
08-03	7B	1	6C	2	09-03	7:00	533			434	34	12		
10-03	7B	2	6C	2	11-03	7:00	53			112	2	3		
12-03	7B	2	6C	2	13-03	7:00	496			650	11	6		
15-03	7B	1	6C	2	16-03	7:00	1838			1753	32	32		
17-03	7B	1	7C	2	18-03	7:00	1348			951	49	26		
18-03	7B	1	6C	1	19-03	7:00	2830			2390	47	25		
18-03	7B	1	6C	1	19-03	7:00								13 CNW
19-03	7B	2	7C	1	19-03	19:00	93			26	2	5		
19-03	7B	1	7C	1	20-03	7:00	3737			3326	91	13	1	
20-03	7B	1	8C	1	20-03	19:00	109			248	3	1		
21-03	7B	2	7C	1	21-03	7:00								1 CNW
20-03	7B	1	7C	1	21-03	7:00	1509			2821	103	12		
22-03	7B	3	7C	1	23-03	7:00	1370			3533	113	26		
24-03	7B	1	7C	2	25-03	7:00	2241			3758	134	42		
26-03	7B	1	6C	2	27-03	7:00	2527			3255	247	36		
28-03	7B	2	8C	1	30-03	7:00	768			4834	184	18		
31-03	7B	1	7C	1	01-05	7:00	600			7932	278	13		
01-04	7B	2	7C	1	02-04	7:00								7 CNW
01-04	7B	2	8C	1	02-04	7:00	11			57	3			
02-04	7B	1	6C	1	02-04	19:00	403			6355	192	12		
02-04	7B	1	7C	1	03-04	19:00								1 CNW
02-04	7B	1	6C	1	03-04	7:00								3 CNW
02-04	7B	1	6C	1	03-04	19:00	215			7506	94	9		
03-04	7B	1	7C	1	03-04	19:00	24			94	3	1		
03-04	7B	1	7C	1	04-04	7:00	337			6900	125	27		
05-04	7B	1	8C	1	06-04	7:00	201			10775	62	4		
07-04	7B	1	7C	1	08-04	7:00	261			11941	26	5		
09-04	7B	2	8C	1	10-04	7:00	12	124		1108	3	4		
12-04	7B	2	8C	2	13-04	7:00	32	29		7105	81	5		
14-04	7B	1	7C	1	15-04	7:00	21	4		1715	26	1		
15-04	7B	1	8C	1	16-04	6:30	42	6		5390	133	4		
15-04	7B	1	8C	1	16-04	6:30								13 CM
16-04	7B	1	10C	1	16-01	19:00				16		1		
16-04	7B	1	8C	1	17-04	6:30	45	9		4696	122	6		
17-04	7B	1	11C	1	17-04	18:30	3			29		3		
17-04	7B	3	10C	1	18-04	7:00	18	1		1695	27	2		
19-04	7B	1	8C	1	20-04	7:30	58	2		2699	124	1		
21-04	7B	2	10C	1	22-04	7:00	27			3860	80	4		
23-04	7B	1	9C	1	24-04	7:30	46			1669	43	4		
26-04	7B	1	10C	1	27-04	7:00	29			1801	93	12		
28-04	7B	1	11C	1	29-04	7:00	9			685	27	10		
29-04	7B	1	11C	1	30-04	7:00	8			474	24	2		
29-04	7B	1	11C	1	30-04	7:00								3 CM
30-04	7B	1	14C	1	30-04	19:00				33	2			
30-04	7B	1	11C	1	01-05	7:00	4			398	9	6		
01-05	7E	2	11C	1	02-05	13:30	64			465	53	51		
03-05	7E	1	13C	1	04-05	7:30	17			516	48	37		
05-05	7E	2	14C	1	06-05	7:30	3			158		60		

Table 1 (cont'd)

Set date	Site	W	Temp	Clarity	Sampling Date	Start Time	CNW	CNH	CNC	CM	COF	CO1	CO2	BB
07-05	7E	2	14C	1	08-05	7:00	4			101		107		
09-05	7E	2	14C	1	10-05	7:00	2			1		112		
12-05	7E	2	14C	1	13-05	7:00	21	13		84	1	55		
13-05	7E	2	14C	1	13-05	20:00		1		4		2		
13-05	7E	3	13C	1	14-05	8:00		71	115	18		88		
13-05	7E	1	14C	1	14-05	19:00		2	3	2		2		
14-05	7E	2		1	15-05	7:00	3	453	658	337	16	169		
19-05	7E	1	14C	1	20-05	8:00	10	311	109	69	34	207		

Legend:
CC - sculpin
CM - chum
CNC - chinook adipose clip
CNH - chinook hatchery
CNW - chinook, wild
CO1 - coho smolt
CO2 - coho 2yr old
COF - coho fry
CT - cutthroat
LL - lamprey
P - perch
RB - rainbow trout
SB - stickleback
SK - sockeye
ST - steelhead
STH - steelhead, hatchery
STW - steelhead, wild

Clarity - 1 Clear
2 Cloudy

Weather 1 Clear
2 Cloudy
3 Raining

Temp - Water temperature

Table 2. Cowichan hatchery chinook release data, 1998.

Release Code	Total Released	Tag Code	Coded-wire tagged	% Tagged	Release Date	Length (mm) Mean	Length (mm) Min	Length (mm) Max	Weight (gm) Mean	Weight (gm) Min	Weight (gm) Max	Condition Coefficient
Early	**76117**		**76117**	**100%**								1.1
		18-27-61	25213		9-Apr-98	69.76	62	78	3.71	2.55	5.2	
		18-27-62	25206		9-Apr-98							
		18-27-63	25698		9-Apr-98							
Late	**84807**		**74630**	**88%**								1.12
		18-28-01	24817		13-May-98	82.32	71	99	6.47	3.84	12.47	
		18-28-02	24890		13-May-98							
		18-28-03	24923		13-May-98							
Hatchery	**49997**		**49997**	**100%**								1.11
		18-28-04	24971		21-May-98	83.44	72	90	6.46	3.85	8.74	
		18-28-05	25026		21-May-98							
Seapen	**51754**		**25167**	**49%**								1.21
		18-32-13	25167		25-May-98	80.52	73	91	6.27	4.8	8.9	
Total	**262675**		**225911**	**86%**								

Total Released above Trap Site **160924**

Release Sites:

Early - upper Cowichan R. (Road Pool) *
Late - upper Cowichan R. (Road Pool) *
Hatchery - released directly from Hatchery
Seapen - released from seapens in Cowichan Bay

* indicates that these fish are released above trapping site

Table 3. Expanded daily catch estimates for the Cowichan River pumphouse site, 1998.

Naturally-reared:

Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Total
25-Feb	983		1101	32963	32963
26-Feb		896	1004	30045	63008
27-Feb		896	1004	30045	93054
28-Feb		896	1004	30045	123099
29-Feb		896	1004	30045	153144
01-Mar	810		907	27162	180306
02-Mar		875	980	29341	209647
03-Mar	941		1054	31554	241201
04-Mar	833		933	27933	269134
05-Mar		866	970	29039	298174
06-Mar	899		1007	30146	328320
07-Mar	504		564	16901	345220
08-Mar		518	580	17370	362590
09-Mar	533		597	17873	380463
10-Mar		514	576	17236	397699
11-Mar		514	576	17236	414935
12-Mar		514	576	17236	432171
13-Mar	496		556	16632	448803
14-Mar		1157	1296	38797	487600
15-Mar		1157	1296	38797	526398
16-Mar	1838		2059	61633	588031
17-Mar		1593	1784	53418	641449
18-Mar	1348		1510	45202	686651
19-Mar	2936		3288	98452	785103
20-Mar	3846		4308	128967	914071
21-Mar	1510		1691	50635	964705
22-Mar		1440	1613	48287	1012992
23-Mar	1370		1534	45940	1058932
24-Mar		1805	2022	60527	1119459
25-Mar	2241		2510	75147	1194606
26-Mar		2384	2670	79942	1274548
27-Mar	2527		2830	84737	1359286
28-Mar		1647	1845	55229	1414514
29-Mar		1647	1845	55229	1469743
30-Mar	768		860	25753	1495496
31-Mar		684	766	22936	1518432
01-Apr	600		672	20120	1538552
02-Apr	419		469	14050	1552602
03-Apr	242		271	8115	1560717
04-Apr	337		377	11301	1572018
05-Apr		269	301	9020	1581038
06-Apr	201		225	6740	1587778
07-Apr		235	263	7880	1595658
08-Apr	261		292	8752	1604410
09-Apr		136	152	4560	1608971
10-Apr	12		13	402	1609373

Table 3 (cont'd)

Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Total
11-Apr		22	25	738	1610111
12-Apr		22	25	738	1610849
13-Apr	32		36	1073	1611922
14-Apr		26	29	872	1612794
15-Apr	21		24	704	1613498
16-Apr	42		47	1408	1614906
17-Apr	48		54	1610	1616516
18-Apr	18		20	604	1617119
19-Apr		38	43	1274	1618394
20-Apr	58		65	1945	1620338
21-Apr		43	48	1442	1621780
22-Apr	27		30	905	1622686
23-Apr		36	40	1207	1623893
24-Apr	46		52	1543	1625435
25-Apr		37	41	1241	1626676
26-Apr		37	41	1241	1627917
27-Apr	29		32	972	1628889
28-Apr		19	21	637	1629526
29-Apr	9		10	302	1629828
30-Apr	8		9	268	1630096
01-May	4		4	134	1630231
02-May	64		72	2146	1632377
03-May		40	45	1341	1633718
04-May	17		19	570	1634288
05-May		10	11	335	1634623
06-May	3		3	101	1634724
07-May		3	3	101	1634825
08-May	4		4	134	1634959
09-May		3	3	101	1635059
10-May	2		2	67	1635126
11-May		11	12	369	1635495
12-May		11	12	369	1635864
13-May	21		24	704	1636568
14-May		12	13	402	1636971
15-May	3		3	101	1637071
16-May		6	7	201	1637272
17-May		6	7	201	1637474
18-May		6	7	201	1637675
19-May		6	7	201	1637876
20-May	10		11	335	1638211
21-May			0	0	1638211
22-May			0	0	1638211
23-May			0	0	1638211
24-May					
	25938			1638211	

Table 3 (cont'd)

Hatchery reared:

Date	Observed	Missing cells Interpolated	24-hour Estimate	Extrapolated Estimates	Cumulative Total
01-Apr			0	0	0
02-Apr			0	0	0
03-Apr			0	0	0
04-Apr			0	0	0
05-Apr			0	0	0
06-Apr			0	0	0
07-Apr			0	0	0
08-Apr			0	0	0
09-Apr			0	0	0
10-Apr	124		131	4820	4820
11-Apr		76	80	2954	7774
12-Apr		76	80	2954	10728
13-Apr	29		30	1127	11855
14-Apr		16	16	622	12477
15-Apr	4		4	155	12633
16-Apr	6		6	233	12866
17-Apr	9		9	350	13216
18-Apr	1		1	39	13255
19-Apr		1	1	39	13294
20-Apr	2		2	78	13371
21-Apr			0	0	13371
22-Apr			0	0	13371
23-Apr			0	0	13371
24-Apr			0	0	13371
25-Apr			0	0	13371
26-Apr			0	0	13371
27-Apr			0	0	13371
28-Apr			0	0	13371
29-Apr			0	0	13371
30-Apr			0	0	13371
01-May			0	0	13371
02-May			0	0	13371
03-May			0	0	13371
04-May			0	0	13371
05-May			0	0	13371
06-May			0	0	13371
07-May			0	0	13371
08-May			0	0	13371
09-May			0	0	13371
10-May			0	0	13371
11-May			0	0	13371
12-May			0	0	13371
13-May	14		14	544	13916
14-May	191		202	7424	21340
15-May	1111		1177	43185	64525

Table 3 (cont'd)

Date	Observed	Missing cells Interpolated	24-hour Estimate	Extrapolated Estimates	Cumulative Total
16-May		765	810	29736	94260
17-May		765	810	29736	123996
18-May		765	810	29736	153732
19-May	420		445	16325	170057
20-May			0	0	170057
21-May			0	0	170057
22-May			0	0	170057
23-May			0	0	170057
	1911		4637	170057	

Table 4. Fyke trap enumeration data from the Cowichan River coho recapture program, 1998.

Date	Coho 1yr	Chinook	Coho fry	Trout fry	OTHER	Temp (C)
23-May-98	11	1				
24-May-98	5	4				
25-May-98			6	7		
26-May-98	1	7	2			
27-May-98	12	11	7	4		
28-May-98	32	144	67	49		
29-May-98	28	48	30	5		17
30-May-98	25	37	29	38		17
31-May-98	30	33	35	10		No temp
01-Jun-98	5	1	1			17
02-Jun-98	69	65	51	8		17
03-Jun-98	8	30	51	4	RB 2	17
04-Jun-98	10	59	69	2		17
05-Jun-98	4	34	84	1		17
06-Jun-98	5	22	90	3	RB 1	17
07-Jun-98	16	22	94		crayfish 1	17.5
08-Jun-98	19	19	137			17.5
09-Jun-98	12	6	151			17
10-Jun-98	6	3	50	2		17
11-Jun-98	14	21	66	3	lamprey	17
12-Jun-98	32	4	23			17
13-Jun-98	3	6	132			17
14-Jun-98	1		27	6		17
15-Jun-98	10	2	49			17
16-Jun-98	2	12	57	3	parr 1	17
17-Jun-98	26	3	8			17
18-Jun-98	4		25	1		18.5
19-Jun-98	18	39	71	7	crayfish	19
Totals:	**408**	**633**	**1412**	**153**		

Table 5. Trap Efficiency Data at the Pumphouse Site, 1998

Pumphouse Site:

Date	Flow	Released		Recovered		% Recovered	
		Chinook	Chum	Chinook	Chum	Chin/Chum	Expansion factor
04-Mar	13935	292		5		1.71%	58.48
18-Mar	11324	300		14		4.67%	21.41
01-Apr	8912	306		11		3.59%	27.86
15-Apr	6110		206		13	6.31%	15.85
29-Apr	7295		300		2	0.67%	149.25
Total:		898	506	30	15	3.21%	31.15
				Chinook only:		3.34%	29.94

Upper Pumphouse Site:

No bismarck tests

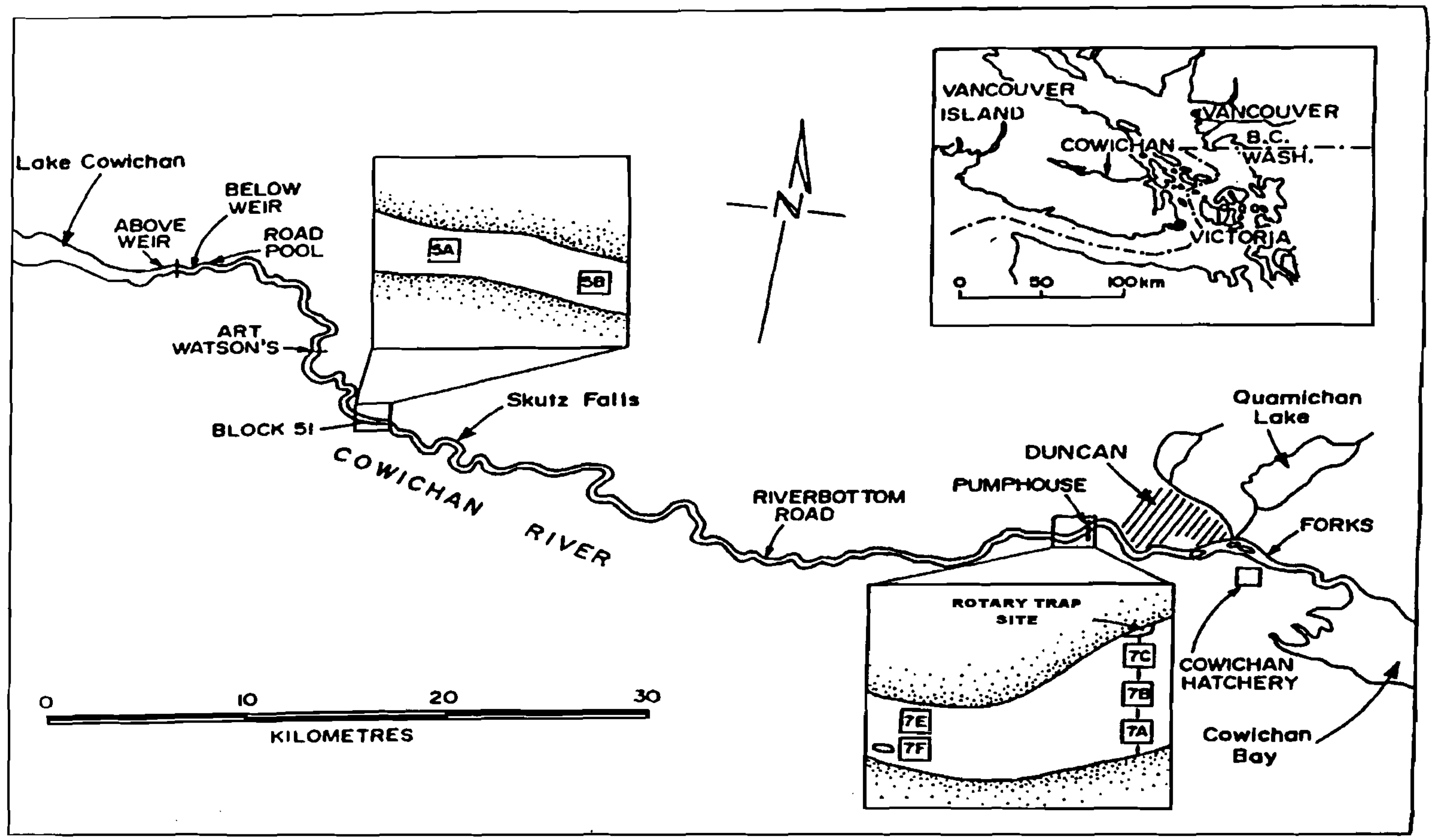


Fig. 1. Cowichan River downstream fry trap locations.

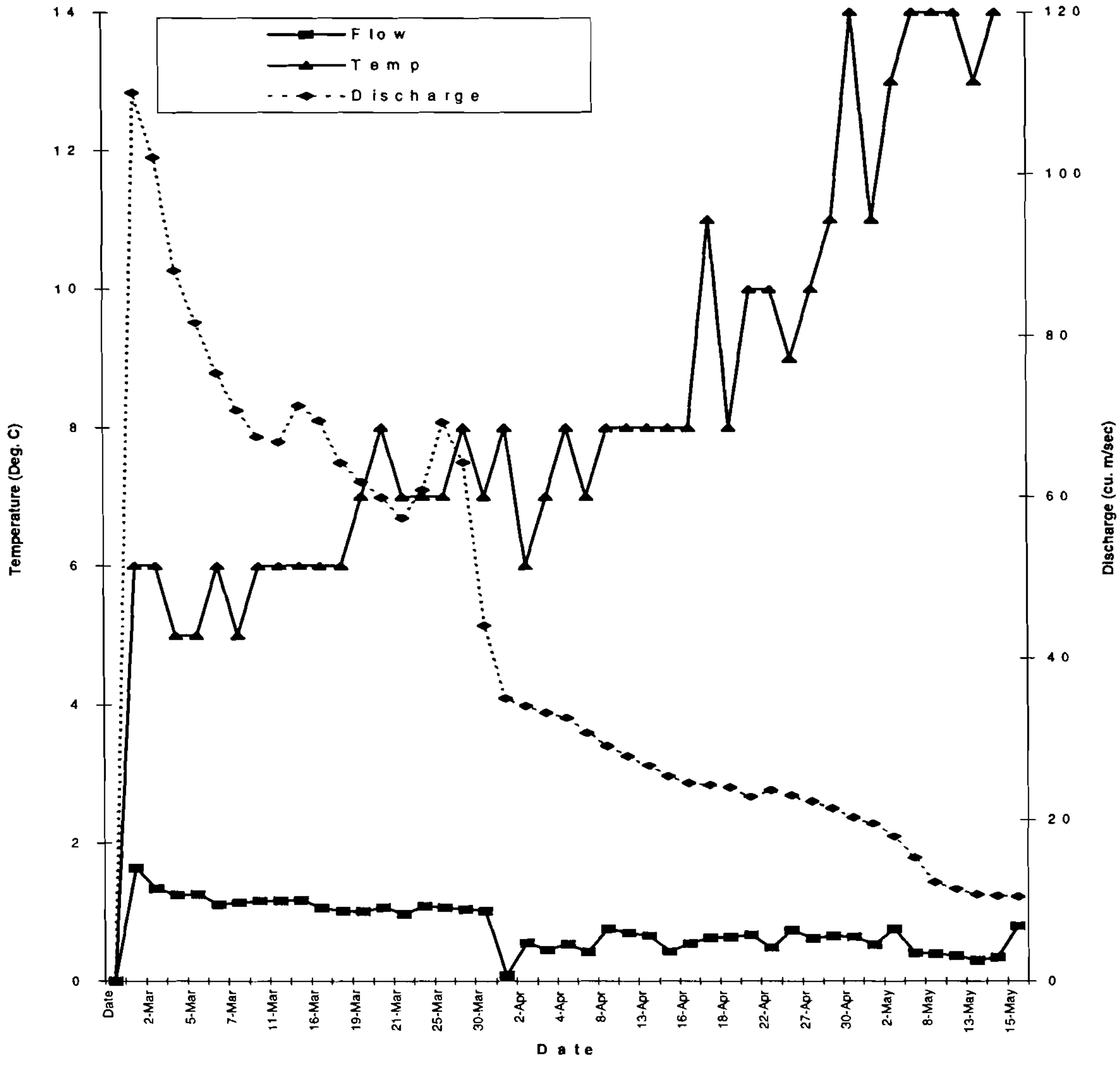
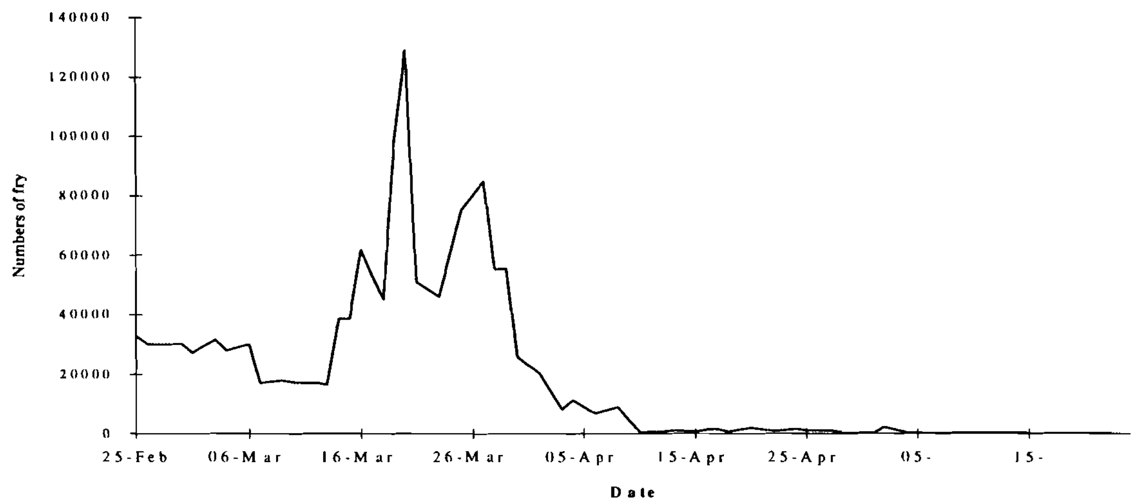


Fig. 2. Biophysical conditions recorded at the pumphouse site, Cowichan River.

Naturally-reared



Hatchery-reared

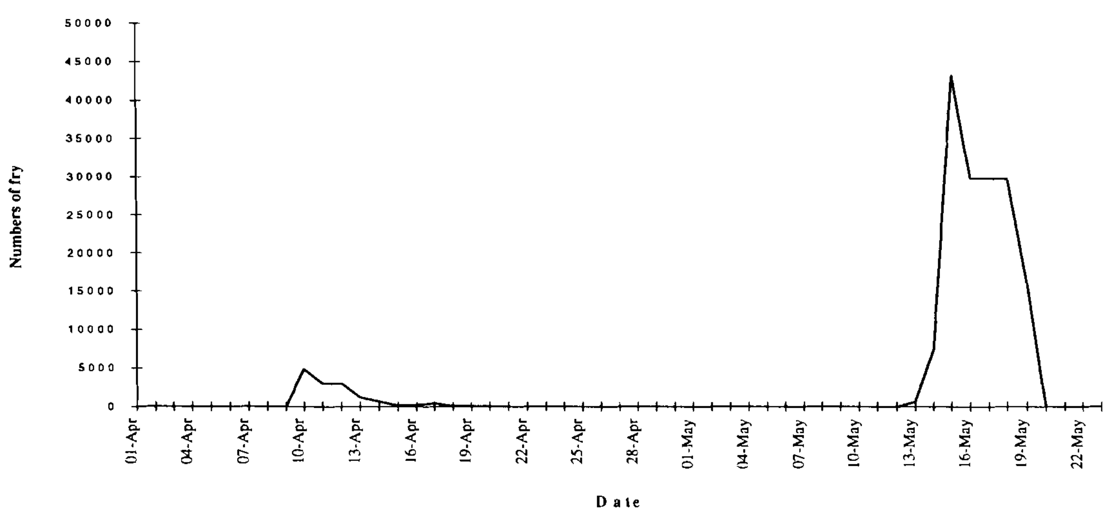


Fig. 3. Daily abundance estimates of naturally-reared and hatchery chinook fry downstream migration, pumphouse site.

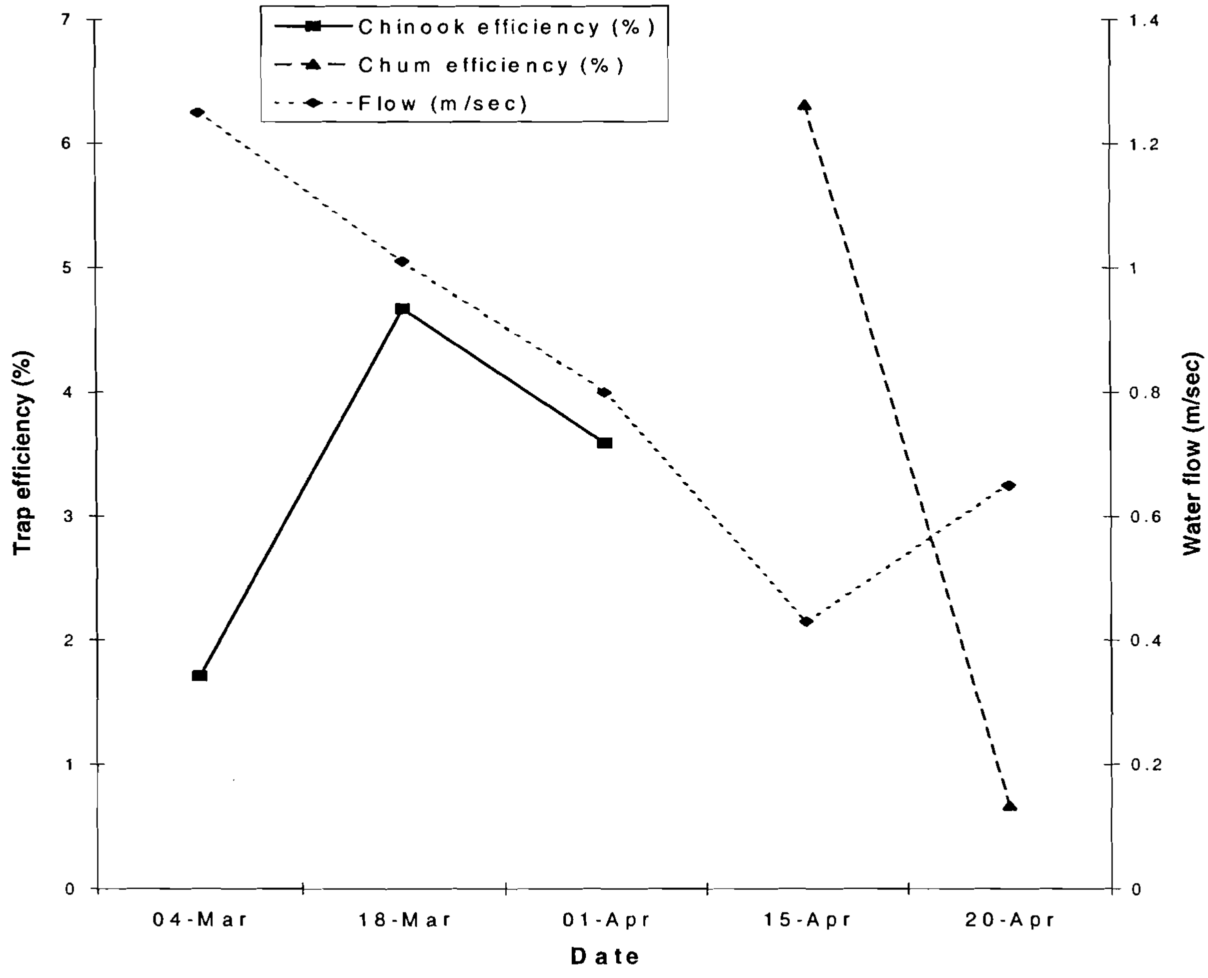
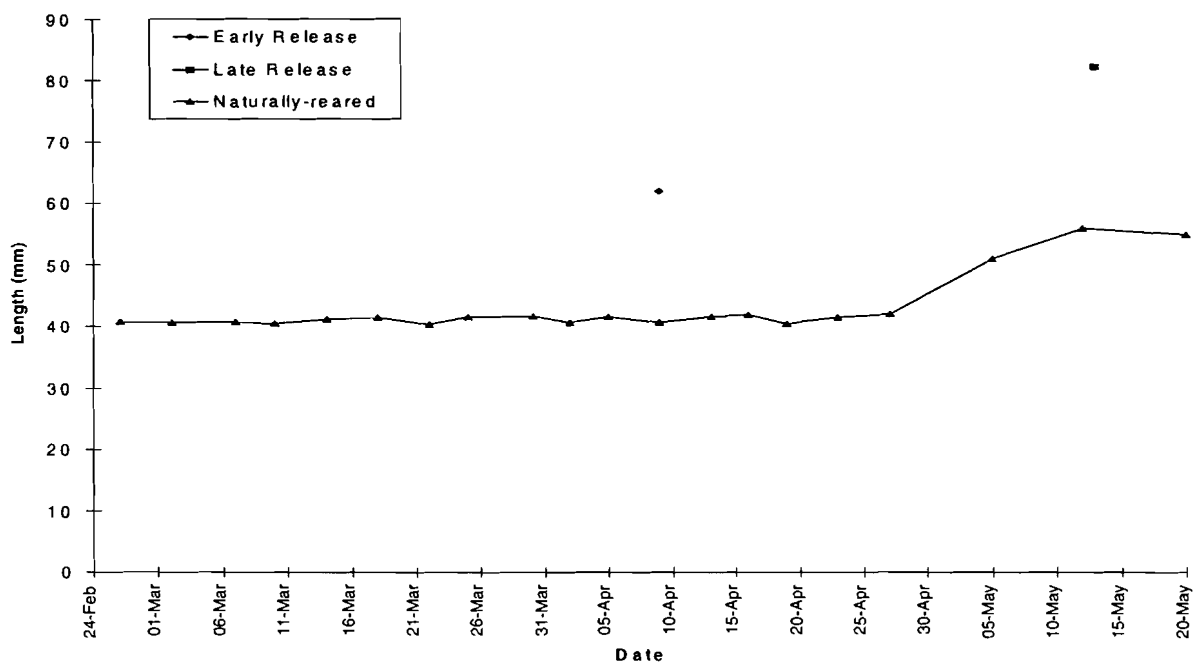


Fig. 4. Rotary trap efficiency vs water flow, pumphouse site, Cowichan River.



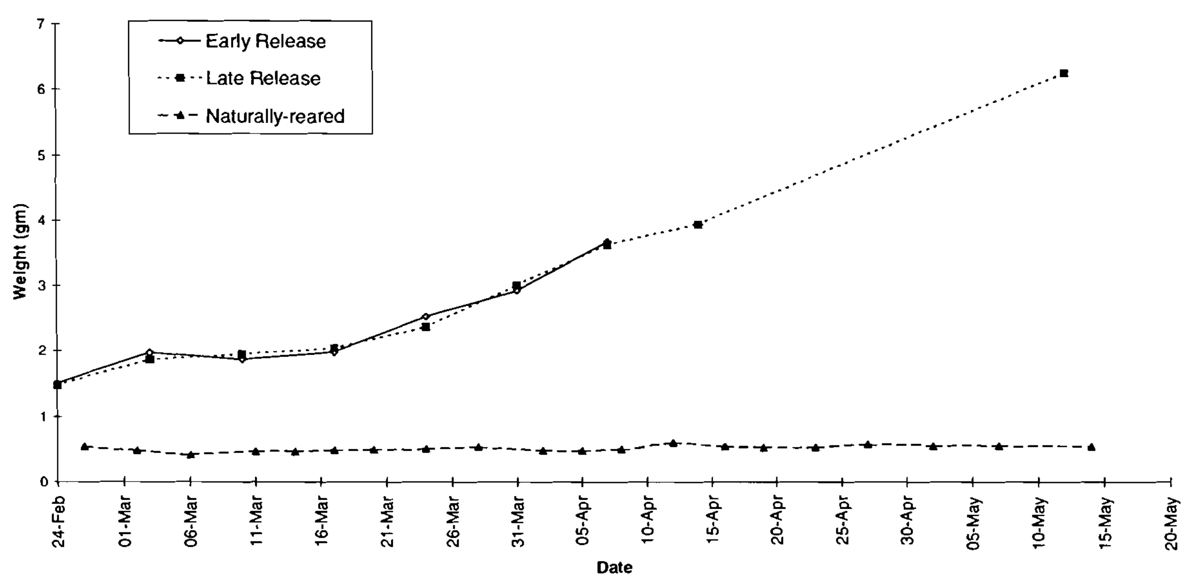


Fig. 5. Length and weight of chinook fry sampled by date, pumphouse site, Cowichan River.

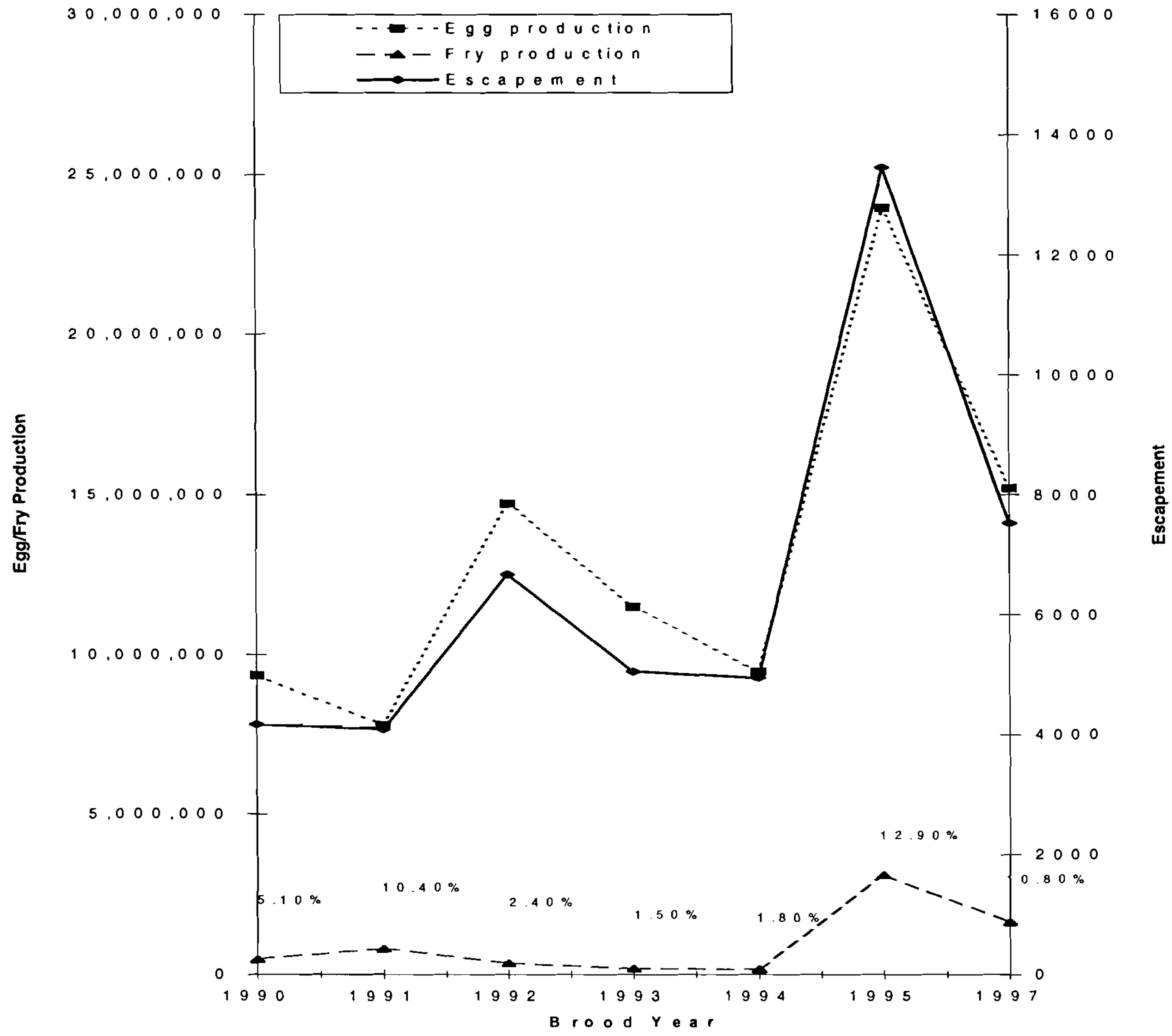


Fig. 6. Egg to fry survival estimates (in brackets) relative to adult escapement, Cowichan River.

Appendix 1. Biosampling data from naturally-reared chinook fry from the pumphouse site, 1998.

Date	26-Feb		02-Mar		04-Mar		05-Mar		05-Mar		06-Mar	
	Lgth(mm)	Wt(gm)*	Lgth(mm)	Wt(gm)*	Lgth(mm)	Wt(gm)*	Lgth(mm)	Wt(gm)*	Lgth(mm)	Wt(gm)*	Lgth(mm)	Wt(gm)*
	39	50	41	51	38	49	40	45	40	51	42	45
	40	59	39	37	40	48	37	32	41	52	40	54
	42	65	43	55	34	29	39	41	41	50	41	54
	40	59	42	53	43	60	41	50	39	48	39	49
	43	65	38	40	39	49	38	45	42	58	40	52
	40	54	42	56	39	36	41	55	44	64	40	43
	42	62	39	38	40	57	38	48	42	47	39	40
	39	48	41	51	42	51	42	51	39	41	39	43
	42	63	43	51	41	51	40	43	39	41	42	59
	40	57	39	38	39	52	40	47	39	42	44	58
	39	47	41	47	42	58	42	53	45	71	42	52
	40	59	42	53	38	40	42	58	41	47	40	51
	41	59	39	48	37	35	38	35	44	72	39	41
	39	48	38	44	37	42	38	38	42	54	42	53
	38	46	43	66	38	48	40	44	42	52	41	49
	41	51	39	53	37	38	41	47	42	55	42	53
	43	63	38	43	34	28	40	52	38	39	40	46
	43	66	38		40	44	40	44	40	47	41	49
	39	40	43	61	39	42	42	55	40	44	40	42
	40	44	43	55	40	49	41	48	39	41	40	38
	42	54	41	53	38	40	38	33	41	51	42	57
	40	51	41	49	37	34	41	46	40	53	38	35
	44	65	40	51	45	62	40	41	40	43	40	40
	40	49	41	49	44	62	38	38	41	53	41	45
	40	49	40	45	43	56	39	38	41	45	42	51
	43	65	40	46	44	56	41	47	43	60	41	42
	42	58	41	49	40	50	45	63	43	54	43	58
	40	47	43	53	41	55	34	29	41	46	41	44
	41	51	38	34	38	40	40	44	38	39	41	41
	41	44	38	34	41	63	40	43	41	58	40	44
Mean length:	40.76		40.46		39.6		39.86		40.93		40.73	
Mean weight::		54.6		48.37		47.46		45.1		50.6		47.6

Appendix 1 (cont'd)

06-Mar		07-Mar		09-Mar		11-Mar		13-Mar		16-Mar		18-Mar	
Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)
40	40	41	46	43	57	44	55	41	47	43	63	39	45
42	52	45	61	37	32	41	46	42	48	38	31	40	50
41	45	42	49	44	58	40	39	47	76	40	47	42	55
38	38	43	65	43	56	41	50	41	45	43	57	39	48
39	48	41	45	41	47	38	37	40	48	42	53	43	63
41	49	42	50	38	37	41	47	40	52	39	42	41	48
41	53	43	54	43	53	46	66	41	48	40	45	42	52
39	43	40	42	38	39	42	54	42	56	43	51	42	52
39	37	40	43	41	47	41	47	40	38	41	43	40	44
40	51	41	49	41	52	42	49	39	38	42	48	41	46
39	42	42	51	38	39	44	50	42	52	44	57	42	48
39	41	44	56	47	72	42	53	42	54	43	53	42	51
41	47	41	48	38	33	39	36	42	48	42	50	42	55
44	59	44	51	39	39	37	30	41	46	42	49	43	53
39	42	40	45	40	45	40	43	41	52	42	50	39	43
41	53	41	46	42	48	39	34	41	42	42	52	38	37
40	43	42	54	38	35	42	53	40	43	40	39	42	59
41	53	42	53	40	46	44	47	40	39	42	52	40	47
44	59	43	52	38	40	40	43	43	57	44	60	41	47
40	49	43	54	41	47	43	52	38	35	44	50	39	40
39	38	44	61	43	58	38	39	42	52	41	47	40	49
39	43	43	51	43	53	42	58	39	38	39	41	41	46
44	62	42	48	37	35	40	38	44	55	42	50	39	48
41	50	42	45	38	39	39	35	37	33	40	44	41	48
42	52	41	53	43	52	41	39	40	34	43	50	43	58
42	56	42	52	42	50	41	45	40	39	43	57	41	45
42	53	41	48	40	39	41	50	40	41	43	59	43	55
41	45	42	53	39	45	42	49	45	60	40	43	41	47
41	45	39	41	39	43	42	51	41	49	41	47	42	49
39	43	40	39	40	49	42	43	39	38	39	44	42	51
40.6		41.86		40.46		41.13		41.0		41.56		41.0	
	47.7		50.16		46.16		45.93		46.76		49.13		49.3

Appendix 1 (cont'd.)

19-Mar		20-Mar		21-Mar		23-Mar		25-Mar		27-Mar		30-Mar	
Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)
41	44	36	30	47	88	36	32	42	52	41	43	40	42
42	55	39	39	41	48	42	52	42	52	40	47	43	56
42	54	37	34	37	40	42	62	42	49	42	59	42	60
41	51	41	47	41	55	41	54	41	46	43	59	40	49
40	48	42	52	41	50	41	54	42	46	44	59	39	46
39	42	39	39	42	51	40	45	42	46	42	57	42	63
37	41	39	39	45	83	39	45	40	46	40	47	42	55
42	51	42	54	41	55	41	45	41	49	41	50	39	39
43	55	40	46	45	76	42	57	42	52	42	51	43	63
42	54	40	42	40	49	44	62	42	51	41	50	42	56
42	57	39	35	40	49	42	56	41	51	39	40	43	59
41	53	41	54	42	53	43	54	43	56	42	55	40	40
36	31	43	57	43	65	40	47	45	67	38	41	40	45
42	57	40	44	44	70	39	46	39	42	39	42	47	82
41	52	39	48	43	71	42	59	44	65	43	57	39	42
40	45	41	49	42	62	41	48	41	44	41	49	40	46
42	48	39	44	38	47	40	49	39	43	40	48	44	67
41	49	37	40	41	53	41	50	42	55	43	61	43	57
41	60	39	46	41	60	43	53	42	54	43	57	42	55
39	44	42	57	40	55	42	51	42	57	42	63	38	48
40	45	41	58	40	52	41	47	41	52	42	54	44	61
40	54	40	58	41	57	43	55	40	44	41	56	41	50
45	63	41	50	54	63	40	46	41	47	40	49	42	55
38	39	40	58	40	52	43	60	42	54	43	57	43	53
40	46	42	59	41	54	41	48	43	53	42	53	38	41
40	50	43	61	43	58	41	52	41	50	43	58	43	64
41	55	44	71	41	49	43	53	43	64	43	66	45	63
42	55	41	46	39	46	43	57	42	58	43	54	41	47
39	42	40	40	40	49	41	57	42	54	42	58	40	47
41	50	41	45	40	43	41	57	42	59	45	84	47	89
40.66	49.66	40.26	48.06	41.76	56.76	41.26	51.76	41.7	51.93	41.66	54.13	41.73	54.66

Appendix 1 (cont'd)

01-Apr		02-Apr		03-Apr		06-Apr		08-Apr		13-Apr	
Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)
39	47	40	43	42	56	41	53	40	47	45	79
41	51	41	55	45	81	40	42	39	41	40	48
41	52	40	51	41	57	43	60	42	55	43	60
44	66	38	38	42	57	40	50	48	93	40	50
42	50	40	49	39	48	50	102	42	52	42	53
40	47	39	42	39	49	41	51	40	43	40	46
40	46	40	45	41	52	39	36	42	49	40	42
41	47	43	60	46	80	44	56	40	45	42	51
43	57	42	57	42	49	41	53	42	55	43	53
42	54	40	41	40	47	37	33	40	47	41	45
40	44	40	45	42	53	41	48	43	60	43	53
36	31	41	50	39	41	38	38	42	52	43	62
41	48	41	55	40	50	40	45	42	49	50	112
39	41	40	51	42	52	43	60	40	35	40	40
42	53	39	44	42	53	40	45	39	42	41	50
44	62	38	35	42	53	38	39	42	55	38	34
42	51	40	46	43	57	40	46	40	38	40	47
39	38	42	53	44	65	40	51	42	47	40	44
39	39	42	56	41	51	39	49	45	67	40	50
39	41	39	44	43	58	41	53	41	49	42	58
40	43	42	54	41	47	41	55	40	43	44	73
39	44	42	63	41	53	40	51	37	29	40	44
43	60	40	42	40	54	39	48	42	53	40	50
42	58	39	41	44	59	38	41	40	43	42	51
40	43	38	40	41	53	39	48	49	35	40	45
39	42	39	42	39	43	41	48	44	53	41	55
43	58	40	47	41	51	40	51	40	48	43	57
42	56	42	56	41	52	41	52	41	48	41	56
39	41	38	39	43	57	43	64	42	48	38	41
40.63		40.2		41.63		40.63		41.6		41.43	
	48.36		47.93		54.73		50.7		49.26		53.40

Appendix 1 (cont'd)

16-Apr		17-Apr		20-Apr		22-Apr		24-Apr		27-Apr		06-May	
Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)
43	64	44	60	51	129	37	33	40	43	45	77	70	307
43	62	42	64	39	48	43	63	52	132	41	44	54	130
42	54	39	42	40	46	41	58	38	41	40	52	62	213
45	72	46	78	39	48	42	66	41	59	43	64		
42	59	41	48	41	49	39	47	38	48	44	70		
42	58	38	45	38	37	39	48	43	73	39	48		
44	78	40	47	43	71	43	75	45	77	40	56		
43	63	35	39	42	62	40	48	37	37	44	67		
40	53	44	78	40	51	39	48	40	47	40	50		
38	53	40	53	39	44	41	51	43	64	45	78		
43	62	43	55	42	51	38	41	42	59	44	75		
41	53	42	61	41	52	44	65	41	59	48	88		
43	64	42	63	44	75	42	66	43	66	43	59		
42	60	40	47	39	47	39	59	43	47	39	41		
40	53	41	44	41	56	37	30	39	42	38	41		
46	86	42	56	38	44	40	55	40	49	39	46		
42	62	43	61	40	43	41	54	41	58	40	40		
42	61	40	50	41	49	40	53	42	62	43	62		
43	68	45	74	39	51	40	55	41	61	43	69		
42	61	40	46	35	32	41	48	43	67	44	62		
44	67	42	57	42	55	40	52	42	62	38	40		
38	65	38	40	39	49	39	49	44	67	39	37		
39	49	40	48	39	47			40	48	44	62		
43	65	39	44	39	47			39	48	41	54		
42	58	43	70	42	60			47	92	50	111		
39	50	39	42	40	47			42	57	43	57		
41	54	41	50	41	51			40	51	39	41		
42	49	41	52	43	60			41	54				
40	52	40	46	39	42			41	48				
41.93		41.03		40.56		40.22		41.56		42.07		62.0	
	60.63		53.73		53.26		52.90		58.63		58.92		216.66

Appendix 1 (cont'd)

08-May		11-May		13-May		15-May		20-May	
Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)	Lgth(mm)	Wt(gm)
56	160	51	156	265	51	54	141	45	70
				144	58	54	163	62	217
				140	62	67	318	58	188
				197	53			58	184
				129	57			64	261
				151	62			59	183
				181	55			60	195
				142	54			43	66
				127	58			57	175
				157	57			47	95
				138	57				
				153	58				
				148	47				
				98	60				
				175	48				
				105	53				
				102	46				
56.0		51.0		150.11		58.33		55.3	
	160.0		156.0		55.05		207.33		163.4

Appendix 2. Biosampling data of hatchery reared chinook prior to release.

Date	09-Apr-98				12-May-98	
	Lgth(mm)	Lgth(mm)	Wt(g)	Wt (g)	Lgth(mm)	Wt(g)
	72	75	3.96	4.84	87	7.43
	68	70	3.42	4	87	7.15
	65	70	3.01	3.65	99	12.47
	67	71	2.98	3.77	78	4.98
	72	71	3.83	3.88	73	6.25
	78	75	5.2	4.75	81	4.01
	74	66	4.2	3.08	77	5.21
	62	65	2.75	2.8	75	4.66
	74	71	4.87	3.87	86	6.82
	67	66	3.39	3.36	82	5.89
	75	66	5.14	3.36	72	3.86
	68	64	3.31	2.62	87	7.14
	74	67	4.38	3.22	86	6.77
	75	68	4.87	3.4	90	8.4
	73	68	4.07	3.05	75	4.8
	72	68	4.34	3.14	71	3.84
	68	72	3.79	3.91	92	7.78
	73	64	4.34	2.78	90	8.26
	73	75	4.21	4.34	79	5.33
	64		2.55		76	4.55
	72		4.1		84	7.11
	73		4.43		87	7.31
	69		3.49		81	5.52
	68		3.25		80	5.5
	75		4.73			
	63		2.56			
	65		3.04			
	73		4.51			
	68		2.24			
	68		3.19			
	68		3.31			
Mean length	69.76				82.29	
min	62				71	
max	78				99	
Mean weight			3.70			6.29
min			2.24			3.84
max			5.2			12.47