A Preliminary Report on the Adult Chinook Productivity Study Conducted on the Cowichan River During 1995

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A PRELIMINARY REPORT ON THE ADULT CHINOOK PRODUCTIVITY STUDY CONDUCTED ON THE COWICHAN RIVER DURING 1995

by

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ABSTRACT

Nagtegaal, D. A., E. W. Carter and B. Riddell. 1996 A preliminary report on the adult chinook productivity study conducted on the Cowichan River during 1995. Can. Manuscr. Rep. Fish. Aquat. Sci. 2366: 63 p.

In 1995, the Biological Sciences Branch, Pacific Biological Station, conducted a study of chinook salmon (Oncorhynchus tshawytscha) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners, ii) estimation of native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) data collection. A carcass mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 16,134 in 1995. The number of natural spawners was estimated to be 13,452. In addition, a water management plan is described which was intended to aid upstream movement of chinook.

RÉSUMÉ

Nagtegaal, D. A., E. W. Carter and B. Riddell. 1996 A preliminary report on the adult chinook productivity study conducted on the Cowichan River during 1995. Can. Manuscr. Rep. Fish. Aquat. Sci. 2366: 63 p.

En 1995, la Direction des sciences biologiques de la Station biologique du Pacifique a entamé une étude sur la productivité du saumon quinnat (Oncorhyncus tshawytscha) dans la rivière Cowichan. Cette étude, qui est toujours en cours, porte principalement sur : i) le recensement des reproducteurs ; ii) le volume de la pêche autochtone de subsistance ; iii) le recensement des spécimens de recrues issus d'écloserie ; iv) l'échantillonnage biologique et l'examen des micromarques magnétisées codées (MMC). Soulignons qu'une étude consistant à étiqueter les carcasses de reproducteurs pour qu'on les remette à l'eau afin de comparer le nombre de carcasses de reproducteurs étiquetées et non étiquetées a permis d'étayer les résultats obtenus aux barrières de comptage. Pour l'année 1995, l'effectif de remonte total du saumon quinnat adulte - écloseries et frayères naturelles confondues - dans la rivière Cowichan se chiffrait à 16 134, le nombre de reproducteurs issus de frayères naturelles étant estimé à 13 452. Enfin, les auteurs décrivent un plan de gestion des eaux destiné à faciliter la remonte du quinnat.

INTRODUCTION

Considerable interest has been focused towards the chinook salmon (Oncorhynchus tshawytscha) stocks in the southern portion of the Strait of Georgia over the past several years due to the perceived decline in these stocks and their importance to the local fisheries (Farlinger et. al. 1990). The Department of Fisheries and Oceans, Pacific Biological Station, initiated a study of chinook productivity to assess rebuilding strategies and to evaluate the effects of harvest management policies for these stocks. In the fall of 1988, a study was implemented on the Cowichan River with additional information collected from the Squamish and Nanaimo River systems. The objectives of this study include: i) quantitatively determining the optimum spawning requirement for chinook salmon in the Cowichan River (this involved investigations of the determinants of 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) development of guidelines for establishing escapement targets for other B. C. chinook stocks (Nagtegaal et al., 1994a).

Hatchery production of chinook on the Cowichan River began in 1980 (Cross et al.,1991). Chinook fry releases have increased from 64,681 in 1980, to 1.6 million in 1995. Marked releases also began in 1980 and in 1995 approximately 13.5% of the total number of chinook released were coded-wire tagged.

As an adjunct to this study a water management plan, implemented in 1988 (KPA Engineering Ltd. 1991), was maintained on the Cowichan River by the Fisheries Branch. The rationale behind this plan was to increase water flow for a short period (2-5 days) during the early part of the chinook run. This was intended to aid upstream movement of chinook. These fish may otherwise be obstructed in their upstream migration and suffer pre-spawn mortalities due to typically low water levels in the Fall.

The purpose of this report is to present the results of the adult escapement enumeration component of the chinook productivity study conducted on the Cowichan River during the fall of 1995.

METHODS

Components of escapement enumeration include: i) enumeration of chinook salmon at the counting fence; ii) estimation of native food fishery catch; iii) recording of hatchery broodstock removals; iv) collection of biological data and sampling of coded-wire tag (CWT) recoveries; and v) carcass mark-recapture studies for both adult and jack chinook.

A detailed description of the methodology used to collect the above information was presented in Nagtegaal et al. (1994b). Some changes were made in 1995 and are described below. Due to budget restraints the Native food fishery biosampling program was not conducted this year.

The counting fence was placed in the same location as in previous years (Fig. 1).

FENCE OPERATION:

Counts were recorded by fifteen minute intervals for adult and jack chinook, adult and jack coho, and chum. If identification was in doubt those fish were recorded as unknown. Water depth, temperature, and clarity, and weather conditions were recorded four times per day. On a daily basis the fence was cleaned of leaves and other debris. Records of fish collected at the fence by the hatchery staff were also kept.

SWIM SURVEY:

Two swim surveys were conducted in conjunction with Cowichan Tribes Aboriginal Fisheries Management to estimate the spawning population of chinook. The swims were made in the upper section of the river. Each survey was conducted by three experienced swimmers and one person in a canoe who recorded the data. Each swimmer (one in the middle and one on each side of the river) counted the fish seen within their range of visibility. The three swimmers attempted to keep abreast as they approached each pool while the person in the canoe lagged behind within hailing distance. Counts were recorded by pool/riffle and then compiled by river section. When possible the same swim team was used for each survey to maintain consistency in counting procedures. Swim counts were expanded by a factor of 3.4 to derive an escapement

estimate. This expansion factor was consistently applied to both swim counts with no adjustments made for run timing or the changes in the distribution of chinook in the river.

It was intended that the swim survey estimates remain independent of the fence count. Even though no fence count information was passed on to the swim teams during the season, general trends in escapement numbers were known.

During the first weeks of fence operation two swimmers surveyed the large pool immediately below the counting fence. Swims were conducted on Sept. 15, 22, 29, and Oct. 6, 13 to monitor the number of fish holding below the fence. There were some concerns that during low flow conditions, the fence may act as a partial barrier to upstream movement.

NATIVE FOOD FISHERY:

In 1990, a systematic approach was developed by the Cowichan Tribes Aboriginal Fisheries Management program to monitor the fishery more closely and to better estimate the native food fish catch (Paige 1992, 1995). This approach involved recording catch and effort by management zone within the native fishing boundaries (Fig.2). A crew of four observers patrolled the fishery on a daily basis and interviewed fishermen for numbers caught by area and total time spent fishing. In this way, weekly estimates of catch per unit effort (CPUE) were obtained. CPUE was adjusted for daily changes in fishing effort and differences in effort among fishing zones. These data were then extrapolated over time and area to estimate total catch by week.

Since 1988, an observer was employed to independently collect catch and biological data from the in-river chinook spear fishery. No biological data were collected in 1995.

BIOLOGICAL DATA:

Biological data for chinook were only collected from two sources: i) hatchery broodstock samples; and ii) mark/recapture (spawning ground). Hatchery staff collected biological data and recorded the incidence of coded-wire tagged fish from the chinook broodstock. On the spawning grounds chinook were sampled for length, sex, scale, and the presence/absence of an adipose clip. All coded-wire

tagged fish recovered were biosampled and the head removed and frozen for further analysis.

MARK-RECAPTURE:

A multiple capture-recapture program involving the tagging and subsequent recovery of chinook jack and adult carcasses was conducted on the spawning grounds (Sykes and Botsford 1986). All chinook carcasses were individually tagged with a Ketchum[1] aluminum sheep ear tag on the operculum and immediately released in the same area as captured. Location of capture and release, tag number, spawning condition, length, sex, and adipose clip information was recorded for each carcass recovered. Tag numbers of previously marked carcasses were recorded and the carcass returned to the river in the same site as captured.

A two man crew in an inflatable boat daily surveyed the upper section of the river (Fig. 1) and collected all available chinook carcasses. This section of the river above Skutz Falls represents the area where the majority of chinook spawning typically occurs. A second crew collected carcasses from the middle section of the river (Fig. 1). A 4.2 m (14 ft) pole with a gaff hook attached to the end was used to recover carcasses. Some carcasses were likely missed if they ended up in pools too deep for retrieval.

POPULATION ESTIMATE:

Adult chinook salmon escapement estimates were generated from the carcass capture-recapture data using the Petersen model (Chapman modification) stratified by sex and river section (Ricker 1975). As in past years, it was necessary to stratify the data in order to minimize the effects of differential tagging and tag recovery between sexes and river sections. This study follows the stratification outlined in previous reports (Nagtegaal et al. 1995).

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[1]Ketchum Manufacturing Ltd., Ottawa, Canada.

RESULTS

ENUMERATION FENCE:

In 1995, the counting fence was operated from Sept. 8 through to October 18. Due to impending high water conditions the fence was removed somewhat earlier than in previous years. Daily counts at the enumeration fence are contained in Table 1, and compared with water depth recorded at the fence (Fig. 3). Total counts recorded during this period were: 10,715 adult chinook; 7,906 jack chinook; 8,613 adult coho; 1,319 jack coho; 95 chum and 15 unidentified fish.

During the season, more jack chinook entered the river earlier than adult chinook. Daily counts were summarized by one hour intervals (Table 2) and we note that peak movement of adult and jack chinook occurred between 0700 and 0900. Approximately 61% of adults and 56% of jacks migrated past the fence during daylight hours.

During several shifts throughout the migration period an independent count was made at the enumeration fence to determine the accuracy of the counting procedure and species identification. On several occasions, fish were visually identified by an observer in the counting tower and then captured in the fish trap and identified by a second observer. Of the 96 fish examined, two fish (2.1%) were incorrectly identified. Errors were made in mis-identification of jack or adult fish.

SWIM SURVEYS:

A summary of visual surveys conducted by Fishery Officers and Cowichan Tribes Aboriginal Fisheries Management from 1981-1995 is presented in Table 3. Total escapement estimates for each year are for adult chinook only. Swims in 1995 were conducted in the upper section of the river (Birdhouse to Three Firs pool; Fig. 1) on Sept. 28 and Oct. 25. The 1995 escapement of adult chinook was determined to be 15,500 (Paige, pers. comm.) but was primarily based on the fence count. Due to extenuating circumstances, insufficient number of swim surveys were conducted to properly estimate total escapement. The first swim survey was conducted under good conditions (low water and clear visibility), but the conditions were not as good for the second swim (higher water and poorer visibility).

Table 4 lists the results of the swims conducted in the main pool below the fence. Although there were always fish in this pool, there was no indication that the fence obstructed the upstream movement of these chinook.

NATIVE FOOD FISHERY:

Estimates of the native food fish catch of chinook since 1981 are listed in Table 5. The catch estimate of 533 adults and 120 jacks was determined by the Cowichan Tribes Aboriginal Fisheries Management group. According to our observations, the adult chinook catch was quite good this year (Fig. 4) since optimal fishing conditions prevailed. It was very difficult to assess the quality of the data collected from these sources because the entire fishery was not monitored due to unforeseen circumstances (Paige, pers. comm.)

HATCHERY COMPONENT:

In 1995, 2,149 adult chinook were removed from the river by the Cowichan River hatchery staff, of which 92% were collected below the enumeration fence (Table 6). The hatchery staff (D. Millerd, pers. comm.) indicated they had met their target this year (Table 7). Primarily 3 and 4 year old chinook were used for broodstock (Table 8).

BIOLOGICAL DATA:

Equal numbers of adult and jack chinook were sampled on the spawning grounds (Tables 9 and 10). More adults were recovered on the spawning grounds in the upper section than in the middle section of the river. Adult chinook were comprised of 3 and 4 year old fish (Table 11).

Length-frequency summaries of chinook broodstock collected and sampled at the hatchery are listed in Table 12. The hatchery staff randomly sampled approximately 25% of all broodstock collected and then selectively sampled all remaining adipose clipped chinook. The adipose mark rate in the random sample was 5.4% for males, 15% for jack chinook, and 6.6% for females. The mark rate for chinook from hatchery samples was comparable to the rate observed on the spawning grounds.

Coded-wire tag (CWT) recovery information for chinook sampled on the spawning ground is listed in Table 13. A summary of chinook releases from the Cowichan hatchery by brood year is listed in Table 14. A cursory look at CWT recoveries from 1991-93 brood year releases relative to the total number of fish released indicates that proportionately fewer recoveries were observed for the Lake pen release group.

WATER RELEASE STUDY:

The release of additional water stored in Lake Cowichan occurred on Sept. 22 at 8:00 AM. Due to low water levels very little storage was available for release. The pulse of water (7.1 cu m/sec) was maintained for only a 24 hr period. Water temperature and stage were monitored at the counting fence (Table 15) and total discharge recorded at the Water Survey Canada recording station located below the Island highway in Duncan (Table 16). Note that with the increased flow a very slight increase in the daily chinook count occurred (Fig. 3). The increase in chinook upstream movement was more substantial in previous years.

MARK-RECAPTURE:

Table 17 contains a summary of the carcass capture-recapture data by tagging period. A total of 705 adult and 276 jack chinook carcasses were tagged and released in the upper river section and 111 adults and 42 jacks in the middle river section (Table 18). More than 84% of the adult and 93% of the jack carcasses were tagged but never recaptured. Smaller and lighter jack chinook carcasses are more readily swept downstream and often less likely to be recovered than the heavier adult carcasses. This is generally the case during the fall and a potential source of bias, and due to the high flow this year, this was a significant problem. This was especially the case in the middle river section where the cloudy water, due to high flows, made it particularly difficult to retrieve both adult and jack carcasses.

Stratified Petersen:

The escapement estimate of adults based on carcass mark-recapture data (Table 19) was 6,329 with lower and upper 95% confidence limits of 5,329 and 7,329, respectively. Approximately 74% of the total escapement spawned in the upper river section.

Potential biases:

Some of the typical biases associated with mark-recapture experiments (Ricker 1975) are listed below and were examined in some detail for the carcass mark-recapture data. To minimize bias, fish tagging and recovery occurred concurrently and was stratified by sex and river location.

1. Temporal bias:

Temporal bias in the tagging sample was examined by comparing the mark incidence between periods in the recovery sample (Table 20). There were significant differences in the mark incidence between periods ($P < 0.05$; chi-square; Zar 1984). Mark incidence was highest towards the end of the survey.

Recovery bias was examined by stratifying the application sample by period and comparing proportions recovered (Table 21). Significant differences were observed ($P < 0.05$; chi-square). More tags were recovered that were applied in the beginning of the study. This was primarily due to the fact that water conditions began to deteriorate as the season progressed.

2. Location bias:

Spatial bias was examined by comparing the mark incidence between the upper and middle river sections in the recovery sample (Table 22). There was a significant difference between the upper and middle sections of the river ($P < 0.05$; chi-square). Mark incidence of recoveries in the upper river (14.9%) was much higher than in the middle section (5.0%). This was likely due to the cloudy water conditions which made carcass recovery difficult.

3. Fish size:

Size related bias in the application sample was examined by comparing the continuous post orbital/hypural length frequency distributions of marked and unmarked recoveries from the spawning ground. No significant differences were observed in males or females ($D_{obs} < D_{alpha}$; Kolmogorov-Smirnov two sample test). Size related bias in the recovery sample was examined by comparing the continuous post orbital/hypural length frequency distributions of tagged and recaptured carcasses (Table 23). Again, no significant differences were observed in males or females ($P > 0.05$).

4. Fish sex:

Sex related bias in the application sample was examined by comparing the sex ratio of the marked and unmarked spawning ground

recoveries (Table 24). Bias in the recovery sample was examined by partitioning the application sample into recovered and non-recovered components and comparing the sex ratios in each. In both cases, no significant differences were found ($P > 0.05$; chi-square).

DISCUSSION

ENUMERATION FENCE:

Enumeration data could only be collected for the time the fence was in full operation. Although this was the period during which most chinook were presumed to enter the river we have no count regarding the numbers that may have entered before or after the fence operation. The fence count of 10,715 adults and 7,906 jack chinook should be considered an incomplete count of the total run, but the most accurate one available. Since the daily count of chinook was substantial when the fence count began, we could assume that the run had already started. Based on previous years data prior to Sept. 8, we could reasonably assume that approximately 200 adult chinook had already migrated upstream. Based on information from previous studies (1990-94) for upstream movement after Oct. 18, we estimate that approximately 25% of the run was still to come. This was supported by the observations of good catches in the Native food fishery in the lower river made by the Cowichan Tribes Fisheries Manangement Unit.

The floating fence design adapted well to the considerable changes in flow that occurred during the fall on the Cowichan River. Although it was intended to be self-cleaning, field staff were required to maintain a regular cleaning schedule during times when leafy debris and flooding caused by heavy rains made it difficult for the fence to remain afloat. Due to the considerable number of deciduous trees along the banks of the river, a combination of wind, rain and leaves are the main causes of fence failure. This remains an ongoing problem that is very difficult to overcome (Cousens et. al., 1982; Johnston et. al.,1986).

SWIM SURVEY DATA:

Among the biases typically associated with swim surveys, the extrapolation of actual swim counts to total estimates warrants some consideration (Burns, unpubl). Assumptions concerning the distribution of chinook in the river at the time of the survey are the basis for expanding these counts to estimate total escapement. In 1991, it became apparent that during high water flow conditions in early fall, expansions based on the swim survey results overestimated total escapement (Nagtegaal et al. 1994b, 1994c). The results of the 1992 swim surveys support the hypothesis that during low water flow conditions in late fall, expansions based on swim survey results underestimate the number of spawners. Low flow conditions lead to underestimation of spawners because the distribution of fish in the river is affected by flow. Generally, in low water years, not as many fish make it to the traditional spawning areas above Skutz Falls. Expansion of swim surveys conducted in the upper area alone tend to underestimate the number of fish. Conversely, during high water years most of the fish make it above Skutz Falls so the expansion factor tends to overestimate the number of fish.

Initially lower than average flows followed by substantially higher discharge conditions were observed this year (Fig. 5). Based on the carcass tagging data most chinook spawned in the upper river section. Since each swim survey count was expanded by the same factor, no consideration was made with regards to the distribution of chinook in the river.

NATIVE FOOD FISHERY:

Since we did not have the opportunity to directly assess catch estimation procedures developed by the Cowichan Tribes Aboriginal Fisheries Management unit, no comments could be made regarding the methodologies used. The 1995 catch estimate of 533 adult chinook seemed to be low relative to the fence count, the prevailing fishing conditions and based on Cowichan Tribes Aboriginal Fisheries (CTAF) management information (Paige, pers. comm.) but was determined to be the best available estimate. Since 1991, independent observer estimates of adult chinook catch have been 2 to 3.5 times the amount estimated by the CTAF unit. Based on this information, chinook catch could have ranged from 1000 to 1800 adults.

BIOLOGICAL DATA:

No significant differences were noted in the adipose mark rate between the random broodstock sample recorded by the hatchery staff and the data collected by our field staff. The incidence of adipose clipped fish in the chinook sampled on the spawning ground was (4.4%-males; 4.2%-females) and in the hatchery chinook broodstock sample was (5.4%-males; 6.6%-females). No differences were noted in the size frequency distribution by sex between hatchery and spawning ground samples ($D_{obs} < D_{alpha}$; Kolmogorov-Smirnov, Zar 1984). Typically, the hatchery collects broodstock from various locations in the river and randomly samples 25% to 50% of males, females and jacks at the hatchery after the fish are spawned. In addition, all other adipose-clipped fish collected for broodstock are selectively sampled for production assessment purposes.

WATER RELEASE STUDY:

Weather conditions, water temperature and flow rate all affect the migration timing of spawning salmon. It appears the minor one day water release did not significantly affect upstream movement of chinook. Less than 2% of the total escapement of adults and jacks passed by the fence during the water release period. The weather had been warm and dry for some time prior to the release. To what extent the weather conditions contributed to the impact of the water release on upstream movement is unknown. The effect on chinook survival of increased water temperatures in the river, due to releasing warmer surface water from the lake, is also unknown.

MARK-RECAPTURE:

Typically, fall rains that occur during peak spawning cause high flows and turbid water. Carcasses are often trapped in deep pools and cannot be seen or easily recovered due to the turbid conditions. Conditions for carcass recovery became particularly poor towards the end of the study in 1995, with high flows and cloudy water, especially in the middle river section, making it difficult to recover carcasses. We were only able to tag and sample approximately 8.9% of the total adult chinook escapement.

Stratification by river section and sex was necessary in order to minimize the effects of differential tagging and recovery between sexes and river sections. Some potential biases associated with tagging

and recovery of carcasses were examined and it was assumed that these would significantly affect the population estimate. If we assume that the fence count was the preferred estimate of escapement, then the stratified Petersen estimates based on carcass mark-recapture underestimated escapement by at least 40%.

SEAL PREDATION:

Although seal predation was not directly assessed in this study, it is worthwhile to examine the impact seals have on chinook in Cowichan Bay. In 1988, the number of seals gradually increased from a low of 30 in April to a peak of about 100 in December. According to Olesiuk et al. (1990) harbour seals consume an estimated 9 tonnes of salmon annually in Cowichan Bay. An estimated 23% (Sept.) to 48% (Nov.) of the harbour seal's diet in Cowichan Bay was comprised of salmon (Bigg et. al. 1990). Based on these data, consumption of chinook salmon could potentially range from 500 to 1000 adults. These data were collected in 1988 when low flows in the Cowichan River persisted until the end of October. Predation likely increases the longer chinook salmon remain in the estuary waiting for high water to allow upstream movement. Predation on chinook was estimated to be approximately 500 and likely lower than the past few years due to the high flow conditions.

ESCAPEMENT ESTIMATE:

Escapement estimates for the Cowichan River were primarily based on the fence data since it was assumed that this was the preferred enumeration technique. Total return of adult chinook to the Cowichan River was determined to be equal to the sum of the fence count, the numbers removed for broodstock below the fence, and the number of fish taken by the native food fishery. If we add the fence count to the estimated migration of fish before and after the fence was in place, the total estimated count past the fence site would be 13,593 adult chinook and 9628 jacks. On this basis we calculate the total return of adults to the Cowichan River in 1995 to be 16,134 (Table 25). This should be considered a minimum estimate since these numbers are based on the fence count and some assumptions about the number of fish in the river prior to and after the counting fence was in place. If we include a seal predation estimate of 500, then it is probable that the total return of chinook in 1995 was closer to 16,500 adults. The number of natural spawners was calculated to be 13,452 (Table 25). This was based on the estimate of fish that had migrated past the fence minus the chinook adults removed for broodstock at and above the fence.

Chinook escapements have fluctuated from a low of 1200 in 1986/87 to 16,134 in 1995 (Fig. 6), the largest escapement recorded for the past 40 years. For ten out of the past 16 years escapements have ranged between 5000 and 6000 adults but in recent years escapement numbers have increased substantially. The dramatic increase in escapement this year may in part be due to substantial increases in hatchery production (Fig. 7) and a reduction in commercial and sport fleet effort in 1995.

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Table 1. Daily counts at the enumeration fence site, 1995.

Date (ddmm)	Chinook		Coho		Chum	Unknown[1]
	Adult	Jack	Adult	Jack		
Sep. 08	17	22	0	0	0	0
09	6	78	0	0	0	0
10	33	99	0	0	0	0
11	110	269	0	0	0	0
12	57	198	0	0	0	0
13	31	84	0	0	0	0
14	28	71	0	0	0	0
15	18	53	0	0	0	0
16	13	29	0	0	0	0
17	10	33	0	0	0	0
18	23	65	0	0	0	0
19	291	465	0	0	0	0
20	19	50	0	0	0	0
21	64	57	0	0	0	0
22	129	209	0	0	0	0
23	59	140	0	0	0	7
24	16	28	2	0	0	1
25	150	139	2	0	0	0
26	1269	932	1	0	0	0
27	119	55	2	0	0	2
28	676	360	3	1	0	0
29	396	237	1	0	0	1
30	253	175	5	1	0	0
Oct. 1	63	39	3	0	0	0
2	159	65	10	0	0	0
3	241	130	4	0	0	2
4	29	29	0	0	0	0
5	160	76	2	10	0	0
6	127	86	0	1	0	1
7	226	126	1	2	0	0
8	191	226	1	0	0	0
9	444	379	15	11	0	0
10	2600	1913	1883	296	12	1
11	867	358	1593	145	0	0
12	277	125	284	38	0	0
13	142	76	43	18	0	0
14	118	53	98	28	0	0
15	121	18	441	183	7	0
16	607	135	2336	388	45	0
17	542	211	1713	159	28	0
18	8	1	170	38	3	0
19	6	9	0	0	0	0
TOTAL:	10715	7906	8613	1319	95	15

[1]unidentified salmon

Table 2. Daily counts by time interval at the enumeration fence site, 1995.

Time	Chinook Adult No.	%	Jack No.	%
0000-0100	447	2	387	1
0100-0200	404	1	399	1
0200-0300	427	2	486	2
0300-0400	768	4	635	3
0400-0500	826	4	695	3
0500-0600	505	4	462	3
0600-0700	361	4	406	2
0700-0800	968	4	1050	2
0800-0900	1320	4	860	3
0900-1000	708	9	490	4
1000-1100	209	10	115	9
1100-1200	210	6	106	5
1200-1300	146	4	57	3
1300-1400	124	4	65	3
1400-1500	315	5	94	4
1500-1600	481	3	147	3
1600-1700	459	5	204	5
1700-1800	669	4	355	4
1800-1900	342	6	231	10
1900-2000	198	6	82	11
2000-2100	168	4	100	7
2100-2200	160	2	145	4
2200-2300	205	2	159	2
2300-2400	295	2	176	2

Table 3. Visual survey data collected for the Cowichan River by Fishery Officers stationed in the Duncan subdistrict.

				Chinook				
				Jacks		Adults		
	Method[1]	Date		Count	Estimate	Count	Estimate	River Segment[2]
1981	S	Sept.	12	175		208	1000	2-4
	S	Oct.	2	103		93	1500	2-4
	S		14	364		1160	4000	2-4
	H		22			2000		1-7
	S		23			3200	5000	2-4
Estimate for Season[3]							5500	
1982	S	Sept.	14	199		131	600	2-4
	S	Oct.	13			153		2-4
	H		19	saw few fish on spawning grounds				1-13
	F	Nov.	8				4000	
Estimate for Season							4500	
1983	S	Sept.	8	38		61	254	2-6
	S		15	62		121	504	2-6
	S		28	190		470	1838	1-2
	S	Oct.	7	207		425	1804	2-6
	S		14	802		997	2836	2-7
	S		25	901		1113	4500	1-6
Estimate for Season							4500	
1984	S	Aug.	28	80		84	400	2-5
	S	Sept.	6	25		72		
	S		13	79		80		3-11
	S		19	35		71		2-6
	S		26	291		434		2-6
	S	Oct.	3	205		283		3-7
	S	"		206		282	2200	8-11
	S		23	525		1300	5000	1-6
	S	Nov.	1	350		1276		1-6
Estimate for Season							5000	
1985	S	Sept.	12	39		46	220	2-6
	S		17	42		10		12-13
	S		18	210		33		2-6
	S		27	245		104	456	2-6
	S	Oct.	3	244		99	360	2-6
	S		10	285		219		2-6
	S		16	293		347		2-6
	S		31	229		934	3500	1-6
Estimate for Season							3500	

Table 3. (cont.)

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1986	S	Sept. 9	295		85	300	2-6
	S	18	46		29	300	3-6
	S	24	161		56	350	12-13
	S	Oct. 7	1310		223	1000	2-6
	S	29	613		473	1200	1-6
	S	Nov. 6	1178		491	1200	
	H	8			515		1-13
Estimate for Season						1200	
1987	S	Sept. 9	30	300	10	50	3-8
	S	17	111		16	75	2-6
	S	25	112		16	75	3-6, 11-12
	S	Oct. 6	196	800	115	400	2-6
	S	15	196		96		1-6
	H	16		saw very few spawners			1-13
	S	28	417		468		1-6
	S	Nov. 6	329		649		1-6
Estimate for Season						1200	
1988	S	Aug. 25	100		50		2-6
	S	Sept. 1	271		149	700	2-6
	S	23	1464		271	1000	2-6
	S	Oct. 3	821	1600	1094	3500	2-6
	S	14	2008		2076	4000	1-6
Estimate for Season						5500	
1989	S	Sept. 11	151		58	300	2-6
	S	21	95		39	350	3-6
	S	Oct. 5	95		48	700	2-3
	S	18	719		350	1200	2-6
	S	Nov. 1	1537		2267		2-6
Estimate for Season						5000	
1990	S	Aug. 29	254		54	250	2-6
	S	Sept. 14	385		89	1000	3-6
	S	27	3169		477	2200	2-3
	S	Oct. 19	4297		2382	5000	2-6
Estimate for Season						5300	

Table 3. (cont.)

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1991	S	Sept. 19			1882	6000	2-6
	S	Oct. 2			2873	7500	2-6
	S	17			2924	8700	2-6
	S	31			3502[4]	9000	2-6
Estimate for Season						10000	
1992	S	Sept. 16	5		8		2-5
	S	Oct. 2	124		46	200	2-6
	S	15	359		291	700	2-6
	S	15	113		162		2-6
	S	27	514		797	2000	1-6
	S	28	591		767		1-6
	S	Nov. 13	506		467		1-6
	S	13	450		640[5]		1-6
Estimate for Season						7500	
1993	S	Sept. 23	23		14	47	2-6
	S	30	81		62	210	2-6
	S	Oct. 14	207		199	676	2-6
	S	28	127		327	1111	2-6
	S	Nov. 4	480		987	3355	
Estimate for Season[6]						5200	
1994	S	Aug. 24	39		3		2-6
	S	Sept. 14	67		46	156	2-6
	S	28	421		323	1098	2-6
	S	Oct. 13	1253		1146	3896	2-6
	S	26	442		1450	4930	2-6
Estimate for Season[6]						5500	
1995	S	Sept. 28	294		267	1170	2-6
	S	Oct. 25	490		1798	6653	2-6
Estimate for Season[6]						15500	

[1]S - Swim survey, H - Helicopter survey, F - boat survey
[2]Refer to Fig. 1
[3]Total escapement estimate for adult chinook
[4]516 chinook carcasses were counted in this total
[5]28 chinook carcasses were counted in this total
[6]swim surveys conducted by Cowichan Tribes River Management Unit, total escapement determined by Fishery officers.

Table 4. Cowichan River chinook swim survey data at the fence site, 1995

Date	Area[1]	Chinook Jacks	Chinook Adults	Coho Jacks	Coho Adults
Sept. 15	Fence	60	27		
	First Riffle	20	60		
	Pumphouse Pool	40	20		
Sept. 22	Fence	1	7		
	First Riffle	60	150		
	Pumphouse Pool	250	550		
Sept. 29	Fence	20	45		
	First Riffle	80	420		
	Pumphouse Pool	--	--		
Oct. 6	Fence	40	160		
	First Riffle	300	550		
	Pumphouse Pool	120	80		
Oct. 13[2]	Fence	6	20		
	First Riffle	--	100		
	Pumphouse Pool	--	--		
Oct. 20[2]	Fence				
	First Riffle				
	Pumphouse Pool				
Oct. 27[2]	Fence				
	First Riffle				
	Pumphouse Pool				

[1]Two swimmers counted the number of fish holding under the fence, in the first riffle below the fence, and in the large pool below the fence (Pumphouse pool)
[2]Water was too cloudy to get a good count.

Table 5. Native food fish catch estimates for the Cowichan River.[1]

Year[2]	Adult Chinook	Jack Chinook
1981	1500	1500
1982	1000	1000
1983	250	1000
1984	355	700
1985	1000	1000
1986	800	800
1987	800	800
1988	681	450
1989	1055	250
1990	604	214
1991	270	100
1992	260	12
1993	295	22
1994	345	227
1995	533	120

[1]Includes chinook caught in the native spear fishery and the in-river gillnet fishery.
[2]Since 1988 data collected by Cowichan Tribes River Management unit. Prior to 1988, data were collected by the local Fishery Officers.

Table 6. Summary of chinook broodstock collected by the Cowichan hatchery[1], 1995.

Date		Below fence			At fence			Above fence		
		M	J	F	M	J	F	M	J	F
Sep.	26	80	5	93						
	27	43	6	49						
	29	45	11	71						
Oct.	2	107	9	153						
	3	72	17	126						
	4	135	28	163						
	5	158	39	198						
	6	68	9	74						
	10	38	173	55						
	11				4		13	7	7	4
	12	33	86	44				4		
	13	31	2	38						
	14							3	1	1
	16	7		6				2	4	5
	17							21	3	39
	18							14		22
	19							1		18
	23							30	117	18
	31			4						
Nov.	1			5						
	8		47	2						
Total:		817	432	1081	4		13	82	132	107

[1] Based on hatchery records

Table 7. Adult chinook escapement used for hatchery broodstock, Cowichan River[1].

Year	No. of fish collected
1981	282
1982	534
1983	242
1984	278
1985	175
1986	315
1987	582
1988	678
1989	535
1990	327
1991[2]	1755
1992	1850
1993	2200
1994	1357
1995	2149 2104 A + 564 J.

[1]Barry Cordecedo (Salmon Enhancement Program) provided numbers on broodstock collection from 1981-1987. The brood stock numbers provided included jacks, but no reliable records were kept. It was estimated that about 10-15 jacks were collected per year, except in the first few years in the Cowichan River. These estimates were subtacted from the broodstock numbers provided to give an estimate of the number of adult chinook removed from the system.
[2]In addition, 284 males were removed for broodstock but later returned to the river.

Table 8. Summary of chinook broodstock age data[1], 1995.

Age	Males	Females	Total
2	41	0	41
3	124	102	226
4	46	103	149
5	0	2	2
Total:	211	207	418

Total number of regenerate scales read: 42

[1]Data from random biosampling of hatchery chinook broodstock.

Table 9. Length-frequency of chinook carcasses sampled in the upper river section, 1995.

Length (cm)	Males	Jacks	Females
32	0	0	0
33	0	0	0
34	0	3	0
35	0	8	0
36	0	7	0
37	0	9	0
38	0	17	0
39	0	15	0
40	0	25	0
41	0	13	0
42	0	22	0
43	5	16	0
44	1	21	0
45	4	20	0
46	7	31	0
47	8	14	0
48	5	10	1
49	3	10	0
50	8	1	2
51	3	0	0
52	10	0	2
53	9	0	1
54	10	0	4
55	4	0	6
56	17	0	5
57	10	0	10
58	16	0	16
59	13	0	15
60	17	0	23
61	14	0	19
62	22	0	28
63	26	0	17
64	12	0	25
65	11	0	22
66	13	0	18
67	7	0	16
68	10	0	18
69	7	0	20
70	3	0	9
71	4	0	7
72	2	0	10
73	1	0	4
74	1	0	2

Table 9 (cont)

Length (cm)	Males	Jacks	Females
75	2	0	3
76	0	0	0
77	2	0	0
78	1	0	0
79	1	0	0
80	0	0	0
81	2	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	0	0	0
86	0	0	0
87	1	0	0
Total:	292	242	303
Adipose Clips:	12	6	15
Mark Rate:	4.1%	2.5%	4.9%

Table 10. Length-frequency of chinook carcasses sampled in the middle river section, 1995.

Length (cm)	Males	Jacks	Females
22	0	1	0
23	0	0	0
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	1	0
32	0	0	0
33	0	0	0
34	0	6	0
35	0	0	0
36	0	3	0
37	0	3	0
38	0	2	0
39	0	1	0
40	0	4	0
41	0	5	0
42	0	2	0
43	0	5	0
44	0	3	0
45	0	3	0
46	0	0	0
47	0	1	0
48	0	0	0
49	1	2	0
50	0	0	1
51	2	0	0
52	1	0	0
53	2	0	1
54	3	0	0
55	0	0	1
56	5	0	0
57	1	0	2
58	4	0	2
59	7	0	2
60	3	0	4
61	3	0	6
62	6	0	7
63	2	0	7
64	3	0	1
65	2	0	6
66	0	0	4
67	0	0	4

Table 10 (cont.)

Length (cm)	Males	Jacks	Females
68	2	0	1
69	3	0	1
70	0	0	0
71	0	0	2
72	1	0	1
73	1	0	0
74	0	0	0
75	1	0	0
76	1	0	0
77	0	0	1
78	0	0	0
79	0	0	0
80	0	0	0
81	0	0	0
82	0	0	1
Total:	54	42	55
Adipose clips:	5	2	2
Mark rate:	9.2%	4.8%	3.6%

Table 11. Summary of chinook age data collected on the spawning grounds, 1995.

Age	Males	Females	Total
2	280	26	306
3	203	175	378
4	37	106	143
5	1	1	2
Total:	525	312	837

Total number of regenerate scales read: 155

Table 12. Length-frequency[1] of chinook broodstock collected by the Cowichan hatchery, 1995.

Length (cm)	Males	Jacks	Females
30	0	1	0
31	0	0	0
32	0	2	0
33	0	2	0
34	0	2	0
35	0	5	0
36	0	1	0
37	0	4	0
38	0	2	0
39	0	5	0
40	0	10	0
41	0	8	0
42	2	2	0
43	0	4	0
44	0	4	0
45	0	0	0
46	0	3	0
47	0	1	0
48	2	1	0
49	0	2	0
50	2	0	0
51	1	1	0
52	2	0	0
53	2	0	0
54	6	0	0
55	10	0	0
56	12	0	0
57	8	0	2
58	12	0	5
59	13	0	5
60	10	0	8
61	19	0	22
62	14	0	13
63	11	0	19
64	9	0	18
65	15	0	19
66	13	0	17
67	7	0	15
68	7	0	16
69	3	0	12
70	5	0	14
71	5	0	12
72	3	0	5
73	2	0	6
74	2	0	1
75	2	0	6
76	1	0	2
77	3	0	3
78	1	0	0
79	0	0	6
80	0	0	0
81	1	0	1
Total:	205	60	227
Adipose clips:	11	9	15
Mark rate (%):	5.4	15.0	6.6

[1]Summary of random broodstock sample only.

Table 13. Coded-wire tag code data from chinook sampled on the spawning grounds, 1995

Recovery Date	Length (mm)	Sex	BY[1]	Tagcode[2]	Release[3] location	Recovery[4] location
311095	624	M	92	180209	SEA	Road Pool
311095	708	F	91	180515	ER	Bible Camp
021195	413	J	93	181321	LR	Bible Camp
031195	717	M		no-pin		Marie Canyon
031195	590	M		no-pin		Marie Canyon
031195	419	J	93	181322	LR	Sandy Pool
061195	562	M	93	181322	LR	Marie Canyon
061195	638	M	91	180515	ER	Marie Canyon
071195	591	F		no-pin		Bible Camp
301095	577	M	92	180210	LR	Road Pool
301095	538	M	92	180210	LR	Road Pool
301095	628	F	92	181044	ER	Road Pool
301095	693	M	91	180516	ER	Train Trestle
301095	623	F	92	181043	LP	Train Trestle
301095	552	F	92	181044	ER	Train Trestle
311095	450	J	93	181319	LP	Road Pool
021195	581	F	92	180210	LR	Road Pool
021195	598	F	92	180209	SEA	Road Pool
031195	517	M	92	181044	ER	Road Pool
031195	629	M		no-pin		Road Pool
031195	587	M	92	180550	LR	Road Pool
031195	450	J	93	181319	LP	Road Pool
031195	574	F	92	181043	LP	Road Pool
031195	605	F	92	181043	LP	Road Pool
061195	716	M	91	180522	SEA	Road Pool
061195	465	J	93	181322	LR	Road Pool
061195	605	M		no-pin		Road Pool
061195	629	M	92	180550	LR	Road Pool
061195	559	F	92	180550	LR	Road Pool
061195	374	J	93	181320	ER	Road Pool
061195	673	F		no-pin		Road Pool
061195	600	F	92	181044	ER	Road Pool
071195	438	J	93	181320	ER	Road Pool
071195	630	F		no-pin		Road Pool
071195	594	F	92	181044	ER	Road Pool
071195	578	M	92	181043	LP	Road Pool
141195	365	J		no-pin		Road Pool
161195	600	F		no-pin		Road Pool
161195	422	J	93	181322	LR	Road Pool
161195	609	M		no-pin		Road Pool

[1]refers to brood year
[2]no-pin refers to no CWT pin found; lost pin refers to a pin that was lost in the processing procedure
[3]Release locations:
ER; early hatchery release (during April)
LR; late hatchery release (during May)
LP; hatchery release from Cowichan Lake pen sites (during May)
SEA; hatchery release from sea pens in Cowichan Bay (during June)
MIL; hatchery release from sea pens in Mill Bay (during June)
[4]Recovery locations; refer to Fig 1.

Table 14. Cowichan hatchery chinook releases[1], 1979-1995.

Tag Code	BY	Number Tagged	Number Released	CWT % Mark	Weigh (gm)	Release Date ddmmmyy:ddmmmyy	Release site
021846	79	31628	32134	98.4	2.8	:07May80	0118-COWICHAN RIVER
022060	79	32034	32547	98.4	2.8	:07May80	0399-SKUTZ FALLS
022158	80	52519	65000	80.8	2.3	:09Jun81	0118-COWICHAN RIVER
022307	81	30179	30373	99.4	3.1	:12May82	0118-COWICHAN RIVER
022339	82	49135	224944	21.8	2.9	:14May83	0399-SKUTZ FALLS
022831	83	50613	101000	50.1	4.3	:25May84	0355-KOKSILAH RIVER
NOCN8311	83	0	200000	0.0	4.3	:31May84	0118-COWICHAN RIVER
NOCN8411	84	0	187823	0.0	4.8	13May85:14May85	0118-COWICHAN RIVER
023803	85	25365	25804	98.3	4.3	23May86:24May86	0118-COWICHAN RIVER
023804	85	25455	25895	98.3	4.3	23May86:24May86	0118-COWICHAN RIVER
023911	85	11980	12187	98.3	4.3	23May86:24May86	0118-COWICHAN RIVER
NOCN8619	86	0	321172	0.0	4.0	13May87:22May87	0118-COWICHAN RIVER
NOCN8620	86	0	54608	0.0	3.5	:21May87	0355-KOKSILAH RIVER
024334	87	14298	14334	99.7	3.4	:18Apr88	0118-COWICHAN RIVER
024729	87	25360	25424	99.7	3.4	:18Apr88	0118-COWICHAN RIVER
024730	87	25869	25934	99.7	3.4	:18Apr88	0118-COWICHAN RIVER
024731	87	27428	27497	99.7	7.1	18Apr88:18May88	0185-COWICHAN LAKE
024732	87	27271	27339	99.8	7.1	:18May88	0185-COWICHAN LAKE
024733	87	26911	26978	99.8	7.1	:18May88	0185-COWICHAN LAKE
024734	87	23521	23580	99.7	7.1	:18May88	0185-COWICHAN LAKE
024735	87	26719	26786	99.7	3.4	18Apr88:18May88	0118-COWICHAN RIVER
024945	87	26461	26594	99.5	4.9	:25May88	0324-COWICHAN R UPPER
024946	87	26658	26792	99.5	4.9	:25May88	0324-COWICHAN R UPPER
024947	87	26761	26895	99.5	4.9	:25May88	0324-COWICHAN R UPPER
025008	87	26817	26952	99.5	4.9	:25May88	0324-COWICHAN R UPPER
NOCN8731	87	0	387071	0.0	8.2	:26May88	0324-COWICHAN R UPPER
024860	88	25117	25243	99.5	3.7	:28Apr89	0118-COWICHAN RIVER
025012	88	26595	54768	48.6	6.5	:21May89	0118-COWICHAN RIVER
025013	88	25982	54154	48.0	6.5	:21May89	0118-COWICHAN RIVER
025015	88	23058	24894	92.6	3.7	:28Apr89	0118-COWICHAN RIVER
025016	88	26821	26821	100.0	3.7	:28Apr89	0118-COWICHAN RIVER
025017	88	27611	28175	98.0	3.7	:28Apr89	0118-COWICHAN RIVER
025523	88	27531	56123	49.1	6.5	:21May89	0118-COWICHAN RIVER
025524	88	27205	55378	49.1	6.5	:21May89	0118-COWICHAN RIVER
025749	88	26922	133331	20.2	6.1	:15May89	0185-COWICHAN LAKE
025750	88	27036	133446	20.3	6.1	:15May89	0185-COWICHAN LAKE
025751	88	23106	130107	17.8	6.1	:15May89	0185-COWICHAN LAKE
025752	88	26169	132842	19.7	6.1	:15May89	0185-COWICHAN LAKE
020352	89	28287	28573	99.0	3.4	12Apr90:12Apr90	0118-COWICHAN RIVER
020522	89	27072	36800	73.6	6.5	22May90:23May90	0118-COWICHAN RIVER
020622	89	27787	37242	74.6	6.5	22May90:23May90	0118-COWICHAN RIVER
020623	89	28164	37619	74.9	6.5	22May90:23May90	0118-COWICHAN RIVER
020624	89	28331	37786	75.0	6.5	22May90:23May90	0118-COWICHAN RIVER
020938	89	28312	28312	100.0	3.4	12Apr90:12Apr90	0118-COWICHAN RIVER
020939	89	26218	26218	100.0	3.4	12Apr90:12Apr90	0118-COWICHAN RIVER
026103	89	27145	27145	100.0	3.4	12Apr90:12Apr90	0118-COWICHAN RIVER
026255	89	26400	119674	22.1	7.2	:14May90	0185-COWICHAN LAKE
026256	89	25693	119497	21.5	7.2	:14May90	0185-COWICHAN LAKE
026257	89	25790	119325	21.6	7.2	:14May90	0185-COWICHAN LAKE
026258	89	25219	118748	21.2	7.2	:14May90	0185-COWICHAN LAKE
020333	90	25687	94172	27.3	8.4	15May91:15May91	0185-COWICHAN LAKE
020334	90	25898	94384	27.4	8.4	15May91:15May91	0185-COWICHAN LAKE
020335	90	25739	94224	27.3	8.4	15May91:15May91	0185-COWICHAN LAKE
020336	90	27135	27135	100.0	3.3	17Apr91:17Apr91	0118-COWICHAN RIVER
020337	90	26631	26631	100.0	3.3	17Apr91:17Apr91	0118-COWICHAN RIVER
020338	90	27046	27046	100.0	3.3	17Apr91:17Apr91	0118-COWICHAN RIVER
020339	90	26721	34318	77.9	6.4	21May91:22May91	0118-COWICHAN RIVER
020340	90	26993	34592	78.0	6.4	21May91:22May91	0118-COWICHAN RIVER
020341	90	26533	33995	78.0	6.4	21May91:22May91	0118-COWICHAN RIVER
020342	90	25437	92182	27.6	4.8	17Jun91:18Jun91	0118-COWICHAN RIVER
020343	90	25391	92136	27.6	4.8	17Jun91:18Jun91	0118-COWICHAN RIVER
NOCN9044	90	0	5086	0.0	5.4	26Jun91:26Jun91	0367-COWICHAN ESTUARY
180513	91	26972	336330	8.0	5.0	17May92:17May92	0185-COWICHAN LAKE
180514	91	25964	335584	7.7	5.0	17May92:17May92	0185-COWICHAN LAKE
180515	91	27694	175107	15.8	4.0	21Apr92:22Apr92	0335-COWICHAN R LOWER
180516	91	27148	174834	15.5	4.0	21Apr92:22Apr92	0335-COWICHAN R LOWER
180517	91	27471	248584	11.1	5.3	20May92:21May92	0324-COWICHAN R UPPER
180518	91	27277	248389	11.0	5.3	20May92:21May92	0324-COWICHAN R UPPER
180519	91	27432	160695	17.1	3.8	21Apr92:22Apr92	0335-COWICHAN R LOWER
180520	91	27001	160262	16.8	3.8	21Apr92:22Apr92	0335-COWICHAN R LOWER
180521	91	26871	27444	97.9	6.3	29May92:29May92	0367-COWICHAN ESTUARY
180522	91	26852	27424	97.9	6.3	29May92:29May92	0367-COWICHAN ESTUARY
NOCN9127	91	0	158361	0.0	2.4	25Mar92:25Mar92	0118-COWICHAN RIVER
NOCN9145	91	0	513053	0.0	5.7	19May92:20May92	0324-COWICHAN R UPPER

Table 14 (cont.)

Tag Code	BY	Number Tagged	Number Released	CWT % Mark	Weigh (gm)	Release Date ddmmmyy:ddmmmyy	Release site
180209	92	24770	98974	25.0	6.3	25May93:25May93	0367-COWICHAN ESTUARY
180210	92	26383	327416	8.1	5.9	17May93:19May93	0324-COWICHAN R UPPER
180550	92	25311	326344	7.8	5.9	17May93:19May93	0324-COWICHAN R UPPER
181042	92	53620	412953	13.0	6.5	25May93:25May93	0118-COWICHAN RIVER
181043	92	54235	901937	6.0	5.6	10May93:10May93	0185-COWICHAN LAKE
181044	92	55027	907719	6.1	3.6	07Apr93:07Apr93	0324-COWICHAN R UPPER
NOCN9231	92	0	437840	0.0	3.7	11May93:11May93	0324-COWICHAN R UPPER
021211	93	24875	103900	23.9	6.2	25May94:25May94	3226-COWICHAN BAY
181319	93	49966	1001002	5.0	6.3	05May94:05May94	0185-COWICHAN LAKE
181320	93	50420	684279	7.4	3.8	18Apr94:18Apr94	0324-COWICHAN R UPPER
181321	93	50045	652354	7.7	6.1	18May94:18May94	0324-COWICHAN R UPPER
181322	93	50285	490079	10.3	6.1	24May94:24May94	0118-COWICHAN RIVER
181329	94	25023	103815	24.1	6.1	31May95:31May95	3226-COWICHAN BAY
181436	94	50133	100252	50.0	5.4	30May95:30May95	0118-COWICHAN RIVER
181437	94	49962	418750	11.9	4.0	02May95:02May95	0324-COWICHAN R UPPER
181438	94	49610	939287	5.3	6.3	15May95:17May95	0324-COWICHAN R UPPER
181439	94	49846	101763	49.0	6.5	25May95:25May95	0185-COWICHAN LAKE

Tag code: refers to Coded Wire tag code (NOCN refers to releases unassociated with a given tag code)
BY: refers to brood year

[1]Data compiled from the Mark Recovery Program (MRP) database (Kuhn 1988).

Table 15. Water temperature and depth recorded at the enumeration fence site, 1995.

Date (ddmm)	Depth (cm.)	Temp. (Deg.C)	Date (ddmm)	Depth (cm.)	Temp. (Deg.C)
08/09	300	12	26/09	425	17
09/09	348	12	27/09	428	16
10/09	365	15	28/09	427	16
11/09	428	17	29/09	425	16
12/09	426	19	30/09	438	14
13/09	294	19	01/10	430	15
14/09	426	19	02/10	308	15
15/09	430	19	03/10	435	14
16/09	435	19	04/10	427	14
17/09	421	18	05/10	431	15
18/09	429	18	06/10	435	14
19/09	425	18	07/10	435	15
20/09	427	20	08/10	436	14
21/09	427	19	09/10	452	14
22/09	425	16	10/10	494	14
22/09	431	16	11/10	525	12
22/09	465	18	12/10	548	12
23/09	314	16	13/10	551	12
24/09	418	16	14/10	583	14
25/09	420	17	15/10	610	13
			16/10	651	15
			17/10	748	14
			18/10	776	15

Table 16. Cowichan River daily discharge[1] in cu.m/sec for 1995.

Day	May	June	July	August	September	October	November
1	24.1	6.3	5.4	6.0	5.4	5.9	48.7
2	24.0	6.0	5.8	6.0	5.3	6.2	47.3
3	23.7	5.9	5.5	5.9	5.6	6.2	45.5
4	22.5	6.1	5.7	5.8	5.9	5.9	44.1
5	21.5	6.3	6.1	6.3	5.8	5.7	43.1
6	20.9	6.2	5.7	7.1	5.9	6.3	41.5
7	19.9	5.9	5.5	7.8	5.7	6.4	62.7
8	18.7	6.1	5.5	6.7	6.0	6.7	179.0
9	16.4	6.2	6.0	6.1	5.6	7.5	139.0
10	17.0	6.4	6.5	6.2	5.6	12.6	129.0
11	17.4	6.6	6.3	6.2	5.7	12.5	157.0
12	17.2	6.5	6.1	6.0	5.8	13.6	139.0
13	16.7	6.6	5.8	6.0	5.8	13.9	133.0
14	15.8	6.6	5.8	6.2	6.0	16.5	139.0
15	15.4	6.4	5.9	6.2	5.8	18.9	141.0
16	15.1	6.3	5.7	6.2	5.6	23.4	139.0
17	14.9	6.5	5.9	6.2	5.9	31.8	153.0
18	14.3	6.3	5.7	5.7	5.7	36.3	195.0
19	13.5	6.3	5.8	5.6	5.6	39.1	185.0
20	13.0	6.2	6.3	5.6	5.6	47.0	172.0
21	12.6	6.0	6.2	5.4	5.5	48.1	160.0
22	12.3	6.0	6.0	5.2	6.0	47.0	153.0
23	12.1	5.6	6.0	5.3	7.1	45.7	176.0
24	11.9	5.4	5.9	5.6	5.5	45.0	204.0
25	11.7	5.5	6.0	5.3	5.5	50.4	227.0
26	11.3	5.9	6.4	5.5	5.7	61.9	212.0
27	11.4	5.6	6.2	5.5	5.8	58.5	198.0
28	11.2	5.4	6.0	5.4	5.8	56.5	201.0
29	10.8	5.6	6.3	5.3	5.5	54.6	253.0
30	9.8	5.5	5.9	5.2	6.0	52.6	249.0
31	7.6		5.7	5.5		50.7	
Total:	484.8	183.5	184.8	184.7	178.6	893.7	4356.9
Mean:	15.6	6.1	5.9	5.9	5.7	28.8	146.0

[1]Water Survey of Canada data recorded at the Island Highway bridge in Duncan.

Table 17. Summary of chinook carcasses recovered by river section, 1995.

UPPER RIVER

Release Data						Recovery data	
Date	Loc[1]	Len[2]	Sex[3]	Adip[4]	Tag[5]	Date	Loc
091195	17	477	J	P	1722	201195	23
031195	26	785	M	P	1392	161195	21
141195	15		F	P	1788	161195	13
141195	14		F	P	1787	161195	13
141195	14		F	P	1786	161195	14
141195	14		F	P	1782	161195	14
141195	14		M	P	1784	161195	14
061195	14	602	M	P	1522	161195	14
101195	14		M	P	1761	161195	15
031195	17	582	M	P	1350	161195	15
061195	15	465	J	P	1549	161195	15
071195	15	657	F	P	1634	161195	17
071195	12	680	F	P	1609	161195	17
301095	11	538	M	A	813	061195	15
311095	13	643	M	P	927	061195	15
021195	11	658	M	P	1040	061195	15
061195	10	716	F	P	1454	161195	17
061195	12	592	F	P	1493	161195	17
311095	14	650	F	P	933	061195	15
301095	12	704	F	P	819	061195	15
021195	12	625	F	P	1043	061195	15
021195	14	556	M	P	1070	061195	15
101195	13		F	P	1752	141195	15
061195	14	667	F	P	1521	141195	15
061195	9	445	J	P	1421	141195	15
311095	11	580	M	P	915	141195	16
021195	12	626	M	P	1042	141195	16
311095	13	502	M	P	929	141195	17
061195	9	615	F	P	1409	141195	17
091195	14	640	F	P	1705	141195	17
071195	15	616	F	P	1629	141195	20
061195	12	633	F	P	1487	141195	20
301095	14	594	M	P	843	141195	20
301095	12	702	F	P	818	061195	15
021195	14	635	M	P	1073	061195	15
031195	12	630	F	P	1306	061195	15
031195	12	685	F	P	1300	061195	15
031195	13	619	F	P	1314	061195	15
301095	16	566	M	P	852	061195	15
301095	4	603	F	P	801	061195	15
021195	16	595	F	P	1099	061195	15
061195	10	605	F	P	1434	101195	15
061195	9	617	M	P	1418	101195	15
021195	14	688	F	P	1066	101195	13
091195	8	714	F	P	1682	101195	10
061195	14	678	F	P	1525	101195	11
021195	9	621	F	P	1008	061195	15
301095	17	601	F	P	866	061195	15
301095	17	620	F	P	865	061195	15
021195	16	654	F	P	1089	061195	15
031195	16	431	J	P	1341	061195	15
071195	20	734	F	P	1647	091195	21
301095	24	659	M	P	901	091195	21
031195	13	587	M	A	1309	061195	15
071195	13	643	F	P	1611	091195	17
061195	13	664	M	P	1512	091195	17

Table 17 (cont.)

Release Data						Recovery data	
Date	Loc[1]	Len[2]	Sex[3]	Adip[4]	Tag[5]	Date	Loc
061195	12	468	J	P	1494	091195	17
071195	14	649	M	P	1619	091195	17
061195	12	498	M	P	1483	091195	17
061195	13	699	F	P	1516	091195	17
031195	24	605	F	P	1383	061195	15
031195	12	724	F	P	1301	091195	17
021195	24	675	M	P	1165	061195	15
031195	24	464	M	P	1374	061195	15
031195	24	709	M	P	1373	061195	15
301095	14	632	M	P	841	091195	17
061195	15	567	F	P	1550	091195	17
061195	13	542	F	P	1509	091195	17
021195	17	682	F	P	1109	091195	17
301095	13	725	M	P	824	091195	17
021195	17	652	F	P	1111	091195	17
021195	24	690	F	P	1169	061195	44
061195	10	598	F	P	1435	091195	17
301095	9	527	M	P	809	091195	17
301095	15	664	F	P	831	091195	17
061195	15	381	J	P	1557	091195	15
021195	24	640	F	P	1168	071195	24
031195	24	598	M	P	1375	071195	24
021195	20	598	M	P	1148	071195	15
061195	15	675	F	P	1541	071195	15
021195	10	662	F	P	1015	071195	13
021195	10	654	F	P	1013	071195	8
031195	13	632	M	P	1312	071195	12
061195	13	574	F	P	1507	071195	12
061195	14	559	F	A	1530	071195	14
061195	10	670	F	P	1458	071195	9
301095	24	485	M	P	903	311095	26
301095	21	710	F	P	891	311095	20
311095	12	635	F	P	917	021195	16
311095	14	435	M	P	932	021195	14
301095	10	812	M	P	812	021195	15
311095	16	563	F	P	939	021195	19
311095	16	406	M	P	944	021195	19
301095	16	560	M	P	861	021195	19
311095	17	662	M	P	953	021195	20
301095	20	648	F	P	888	021195	20
311095	12	635	F	P	920	021195	16
311095	17	546	M	P	947	021195	20
301095	14	586	M	P	842	021195	19
311095	20	648	F	P	959	021195	19
311095	15	568	M	P	935	021195	15
311095	15	635	M	P	936	021195	15
301095	15	544	M	P	835	311095	14
311095	20	568	F	P	963	021195	20
301095	21	660	F	P	892	311095	20
311095	11	455	M	P	916	021195	15
301095	8	577	M	A	808	021195	14
301095	6	461	M	P	803	021195	15
311095	10	500	M	P	909	021195	15
311095	12	650	F	P	918	021195	15
311095	11	667	F	P	912	021195	15
301095	21	623	F	A	894	311095	20
021195	16	407	J	P	1092	031195	
021195	17	491	J	P	1108	031195	

Table 17 (cont.)

Release Data						Recovery data	
Date	Loc[1]	Len[2]	Sex[3]	Adip[4]	Tag[5]	Date	Loc
021195	20	705	F	P	1145	031195	
021195	20	391	J	P	1142	031195	
021195	22	443	J	P	1155	031195	
021195	15	650	F	P	1080	031195	
021195	12	455	J	P	1044	031195	
021195	10	406	J	P	1029	031195	
021195	14	632	M	P	1061	031195	
021195	16	678	M	P	1084	031195	
021195	14	600	F	P	1062	031195	
021195	16	682	M	P	1083	031195	
021195	8	443	J	P	1001	031195	
021195	10	621	M	P	1016	031195	
021195	10	474	J	P	1017	031195	
021195	16	435	J	P	1094	031195	
021195	16	464	J	P	1090	031195	
021195	15	423	J	P	1079	031195	
311095	13	467	M	P	931	031195	
021195	15	605	M	P	1078	031195	
021195	13	692	F	P	1054	031195	
021195	16	521	M	P	1082	031195	
021195	16	681	M	P	1097	031195	
021195	13	690	M	P	1056	031195	
021195	16	532	M	P	1101	031195	
021195	14	677	F	P	1076	031195	
301095	21	552	F	A	895	311095	16
311095	26	484	M	P	981	021195	
301095	11	653	F	P	816	311095	20
301095	21	693	M	A	893	311095	16
031195	53	717	M	A	4939	111195	54
031195	60	649	F	P	4916	061195	64
311095	60	600	F	P	4979	061195	60
031195	60	562	M	P	4920	061195	60
031195	60	396	J	P	4914	061195	60
031195	60	431	J	P	4924	061195	60
031195	60	664	F	P	4921	061195	60
031195	60	541	M	P	4923	061195	60

[1]Location code, see Fig. 1.
[2]Orbital-Hypural length in mm.
[3]Sex: M - male
F - female
J - jack
[4]Adipose fin present (P) or absent (A).
[5]Ketchum aluminum sheep ear tag.

Table 18. Summary of chinook carcasses sampled on the spawning grounds[1], 1995.

UPPER RIVER

Date	Male		Female		Jacks	
(dd/mm)	Tagged	Untagged	Tagged	Untagged	Tagged	Untagged
30/10	67	0	42	0	0	0
31/10	52	0	32	0	0	0
02/11	54	0	69	0	80	0
03/11	36	0	28	0	39	0
06/11	48	0	57	0	63	0
07/11	35	0	40	0	39	0
09/11	20	1	24	0	15	0
10/11	9	0	19	0	12	0
14/11	13	0	17	0	14	0
16/11	7	0	22	0	8	0
17/11	0	0	4	0	2	0
20/11	2	0	8	0	4	0
Total:	343	1	362	0	276	0

Date	Male		Female		Jacks	
(dd/mm)	Clipped	Noclipped	Clipped	Noclipped	Clipped	Noclipped
30/10	3	64	3	39	0	0
31/10	1	51	0	32	0	0
02/11	0	54	2	67	0	80
03/11	3	33	2	26	1	38
06/11	3	45	3	54	2	61
07/11	1	34	2	38	0	39
09/11	0	21	0	24	0	15
10/11	0	9	2	17	0	12
14/11	0	13	0	17	1	13
16/11	1	6	1	21	1	7
17/11	0	0	0	4	0	2
20/11	0	2	0	8	0	4
Total:	12	332	15	347	5	271

Table 18 (cont.)

MIDDLE RIVER

Date	Male		Female		Jacks	
(dd/mm)	Tagged	Untagged	Tagged	Untagged	Tagged	Untagged
31/10	13	0	13	0	11	0
02/11	7	0	9	0	6	0
03/11	21	0	17	0	7	0
06/11	13	0	14	0	17	0
07/11	1	0	1	0	0	0
14/11	1	0	1	0	1	0
Total:	56	0	55	0	42	0

Date	Male		Female		Jacks	
(dd/mm)	Clipped	Noclipped	Clipped	Noclipped	Clipped	Noclipped
31/10	1	12	1	12	0	11
02/11	0	7	0	9	1	5
03/11	2	19	0	17	1	6
06/11	2	11	0	14	0	17
07/11	0	1	1	0	0	0
14/11	0	1	0	1	0	1
Total:	5	51	2	53	2	40

[1] Tagged refers to chinook carcasses tagged with a Ketchum sheep ear tag. Clipped refers to chinook carcasses with adipose fin clipped.

Table 19. Petersen chinook escapement estimates by sex, Cowichan River, 1995.

Carcass mark-recapture:

UPPER RIVER

Sex	Escapement estimate	95% Confidence limit	
		Lower	Upper
Male[1]	2,384	1,822	2,946
Female	2,278	1,789	2,767
Total	4,662	3,915	5,409

MIDDLE RIVER

Sex	Escapement estimate	95% Confidence limit	
		Lower	Upper
Male[1]	841	123	1,559
Female	826	127	1,525
Total	1,667	527	2,807

[1] Adult males only, jacks not included

Table 20. Incidence of tagged adult chinook recovered[1] on the spawning grounds by recovery period, Cowichan R., 1995

Recovery Period	Recovered with tag		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 29-Nov. 4	47	34.5	508	53.3	9.2
Nov. 5-11	65	47.8	346	36.3	18.8
Nov. 12-18	24	17.6	89	10.4	26.9
Nov. 19-25	-	-	10	1.0	-
Total:	136	100.0	953	100.0	14.3

[1]includes adult chinook which had lost the tag but had an obvious notch in the operculum or the secondary opercular punch.

Table 21. Proportion of the tag application sample recovered[1] on the spawning grounds, by period, on the Cowichan R., 1995

Application period	Tags applied	Tags recovered[2]	Recoveries (%)
Oct. 29-Nov. 4	463	96	20.7
Nov. 5-11	284	29	10.2
Nov. 12-18	66	5	7.6
Nov. 19-25	10	-	-
Total:	823	130	15.8

[1]includes tag recovery for adult chinook only.
[2]includes only those fish recovered with tag intact

Table 22. Incidence of tagged adult chinook recovered[1] on the spawning grounds by section of river and by period, Cowichan R., 1995.

Upper River

Recovery Period	Recovered with tag		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 29-Nov. 4	45	36.0	425	50.9	10.6
Nov. 5-11	57	45.6	310	37.1	18.4
Nov. 12-18	23	18.4	86	10.3	26.7
Nov. 19-25	-	-	14	1.7	-
Total:	125	100.0	835	100.0	14.9

Middle River

Recovery Period	Recovered with tag		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 29-Nov. 4	-		80	67.2	-
Nov. 5-11	6	100.0	37	31.1	100.0
Nov. 12-18	-	-	2	1.7	-
Nov. 19-25	-	-	-	-	-
Total:	6	100.0	119	100.0	5.0

[1]includes adult chinook which had lost the tag but had an obvious notch in the operculum or the secondary opercular punch.

Table 23. Summary statistics for Kolmogorov-Smirnov length-frequency comparison for tagged and recaptured chinook carcasses.

Length (cm)	Cumulative Frequency						Difference		
	Males Tagged	Males Recaps	Females Tagged	Females Recaps	Total Tagged	Total Recaps	Males	Females	Total
32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.004
35	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000	0.013
36	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.022
37	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.000	0.032
38	0.000	0.000	0.000	0.000	0.053	0.007	0.000	0.000	0.045
39	0.000	0.000	0.000	0.000	0.070	0.015	0.000	0.000	0.056
40	0.000	0.000	0.000	0.000	0.100	0.015	0.000	0.000	0.085
41	0.000	0.000	0.000	0.000	0.116	0.030	0.000	0.000	0.086
42	0.000	0.000	0.000	0.000	0.142	0.037	0.000	0.000	0.105
43	0.017	0.000	0.000	0.000	0.167	0.045	0.017	0.000	0.122
44	0.021	0.019	0.000	0.000	0.194	0.075	0.002	0.000	0.119
45	0.034	0.019	0.000	0.000	0.222	0.082	0.016	0.000	0.140
46	0.058	0.074	0.000	0.000	0.268	0.119	0.016	0.000	0.148
47	0.086	0.093	0.000	0.000	0.294	0.149	0.007	0.000	0.145
48	0.103	0.111	0.003	0.000	0.313	0.164	0.008	0.003	0.149
49	0.113	0.130	0.003	0.000	0.329	0.179	0.017	0.003	0.149
50	0.140	0.185	0.010	0.000	0.342	0.201	0.045	0.010	0.140
51	0.151	0.185	0.010	0.000	0.345	0.201	0.035	0.010	0.144
52	0.185	0.204	0.017	0.000	0.360	0.209	0.019	0.017	0.151
53	0.216	0.241	0.020	0.000	0.372	0.224	0.025	0.020	0.148
54	0.250	0.278	0.033	0.016	0.388	0.246	0.028	0.017	0.142
55	0.264	0.296	0.053	0.032	0.400	0.261	0.033	0.021	0.139
56	0.322	0.333	0.069	0.063	0.427	0.291	0.011	0.006	0.135
57	0.356	0.370	0.102	0.111	0.450	0.328	0.014	0.009	0.122
58	0.411	0.426	0.155	0.111	0.489	0.351	0.015	0.044	0.138
59	0.455	0.481	0.205	0.127	0.522	0.381	0.026	0.078	0.142
60	0.514	0.537	0.281	0.206	0.570	0.440	0.023	0.074	0.130
61	0.562	0.556	0.343	0.238	0.609	0.463	0.006	0.105	0.147
62	0.637	0.593	0.436	0.333	0.669	0.522	0.044	0.102	0.147
63	0.726	0.667	0.492	0.381	0.720	0.575	0.059	0.111	0.146
64	0.767	0.722	0.574	0.460	0.765	0.634	0.045	0.114	0.130
65	0.805	0.741	0.647	0.603	0.804	0.709	0.064	0.044	0.095
66	0.849	0.815	0.706	0.667	0.841	0.769	0.035	0.040	0.072
67	0.873	0.815	0.759	0.714	0.869	0.791	0.058	0.045	0.078
68	0.908	0.889	0.818	0.794	0.902	0.858	0.019	0.025	0.044
69	0.932	0.926	0.884	0.857	0.934	0.903	0.006	0.027	0.031
70	0.942	0.926	0.914	0.905	0.949	0.925	0.016	0.009	0.023
71	0.955	0.944	0.937	0.952	0.962	0.955	0.011	0.015	0.007
72	0.962	0.944	0.970	0.984	0.976	0.970	0.018	0.014	0.006
73	0.966	0.963	0.983	1.000	0.982	0.985	0.003	0.017	0.003
74	0.969	0.963	0.990	1.000	0.986	0.985	0.006	0.010	0.001
75	0.976	0.963	1.000	1.000	0.992	0.985	0.013	0.000	0.007
76	0.976	0.963	1.000	1.000	0.992	0.985	0.013	0.000	0.007
77	0.983	0.963	1.000	1.000	0.994	0.985	0.020	0.000	0.009
78	0.986	0.963	1.000	1.000	0.995	0.985	0.023	0.000	0.010
79	0.990	0.981	1.000	1.000	0.996	0.993	0.008	0.000	0.004
80	0.990	0.981	1.000	1.000	0.996	0.993	0.008	0.000	0.004
81	0.997	1.000	1.000	1.000	0.999	1.000	0.003	0.000	0.001
82	0.997	1.000	1.000	1.000	0.999	1.000	0.003	0.000	0.001
83	0.997	1.000	1.000	1.000	0.999	1.000	0.003	0.000	0.001
84	0.997	1.000	1.000	1.000	0.999	1.000	0.003	0.000	0.001
85	0.997	1.000	1.000	1.000	0.999	1.000	0.003	0.000	0.001
86	0.997	1.000	1.000	1.000	0.999	1.000	0.003	0.000	0.001
87	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000
D_{obs} =							0.064	0.114	0.151

$D_{.05,56}$ = .178

Table 24. Sex composition of application and recovery samples of Cowichan River chinook, 1995

Sex		Application sample			Recovery sample		
		Recovered	Not Recovered	Total	Marked	Unmarked	Total
Male	Percent	40	34	35	40	34	35
	No.	54	289	343	54	238	292
Jacks	Percent	13	30	28	13	32	29
	No.	17	259	276	17	225	242
Female	Percent	47	36	37	47	34	36
	No.	63	300	363	63	240	303
Total:	No.	134	848	982	134	703	837

Table 25. Total adult chinook returns to the Cowichan River, 1975-1995.

Year	Natural spawner	Brood stock	Native catch	Total return
1975	5000		900	7400
1976	3460		1000	4460
1977	4150		1000	5150
1978	4370		500	4870
1979	7750	195	500	9445
1980	5950	337	1500	7787
1981	6050	282	1500	7832
1982	5450	534	450	6434
1983	4550	242	250	5642
1984	5050	278	355	5683
1985	3550	175	468	4193
1986	1250	315	481	2046
1987	1200	582	455	2237
1988	4712	678	681	6071
1989	996[1]	535[2]	1055	2586
1990	4164	326	604	5094
1991	4086[3]	1755	270	5065
1992	6676	1850	260	8678
1993	5047	1970	295	7312
1994	4936	1357	345	6638
1995	13452[4]	2149	533	16134[4]

[1]For 1989 to the present, the number of natural spawners is calculated as the number of adults recorded at the fence minus the adults removed for broodstock above the fence.
[2]Total broodstock removed.
[3]Includes 2000 adult chinook estimated to have passed by the fence during the period of high water
[4]Includes the fence count and an estimate of the numbers of fish that entered the river prior to and after the fence was in place.

FIGURES

Fig. 1 Cowichan River Survey Areas:

Swim survey locations were:

1 - Bird House pool
2 - Road pool
3 - Train trestle (mile 70.2)
4 - Old pick-up site
5 - Maple tree
6 - Three Firs pool
7 - Skutz Falls
8 - Marie Canyon
9 - Bible Camp
10 - Cowichan side channel
11 - Sandy pool
12 - Sewer
13 - JC pool

Swim survey areas:

Bird House (1) to Three Firs pool (6) represents the Upper survey section.

Marie Canyon (8) to enumeration fence (A) represents the Middle survey section.

A - refers to the adult enumeration fence

Tag recovery locations:

Locations numbered 1 to 45 are in the upper river section, those numbered 46 to 83 are in the middle river section.

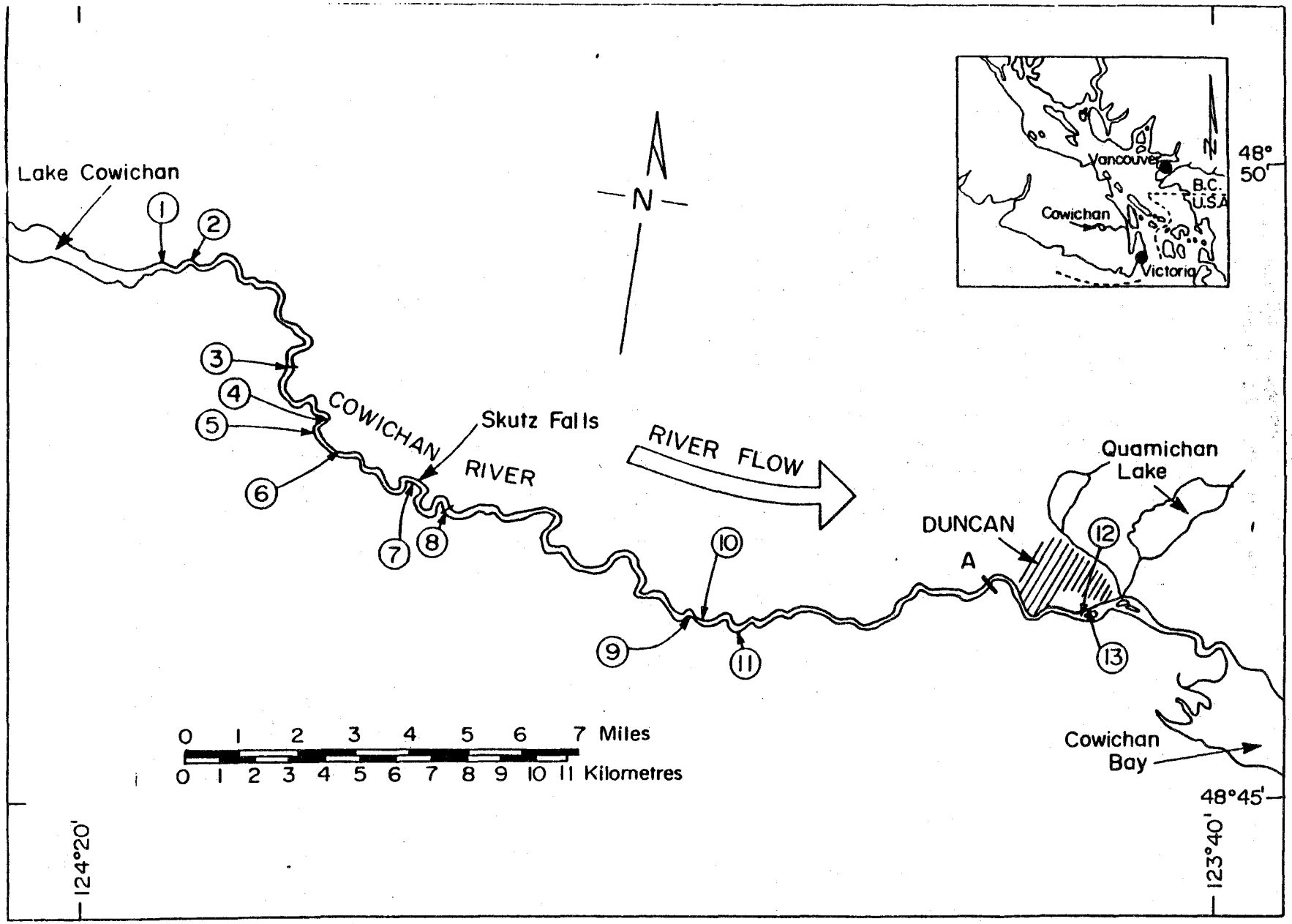

Lake Cowichan
1
2
3
4
5
6
7
8
9
10
11
12
13
COWICHAN
RIVER
Skutz Falls
RIVER FLOW
DUNCAN
Quamichan
Lake
A
Cowichan
Bay
N
Vancouver
B.C.
U.S.A.
Cowichan
Victoria
48°
50'
48°45'
124°20'
123°40'
0 1 2 3 4 5 6 7 Miles
0 1 2 3 4 5 6 7 8 9 10 11 Kilometres

Fig. 2 River Management Zones for Native Food Fishery

A-Cliffs to Silver bridge

B-Silver bridge to JC's place

C-Quamichan to Black creek

D-Powerline to Elliot's barn

E-Elliot's barn to Brian's pool

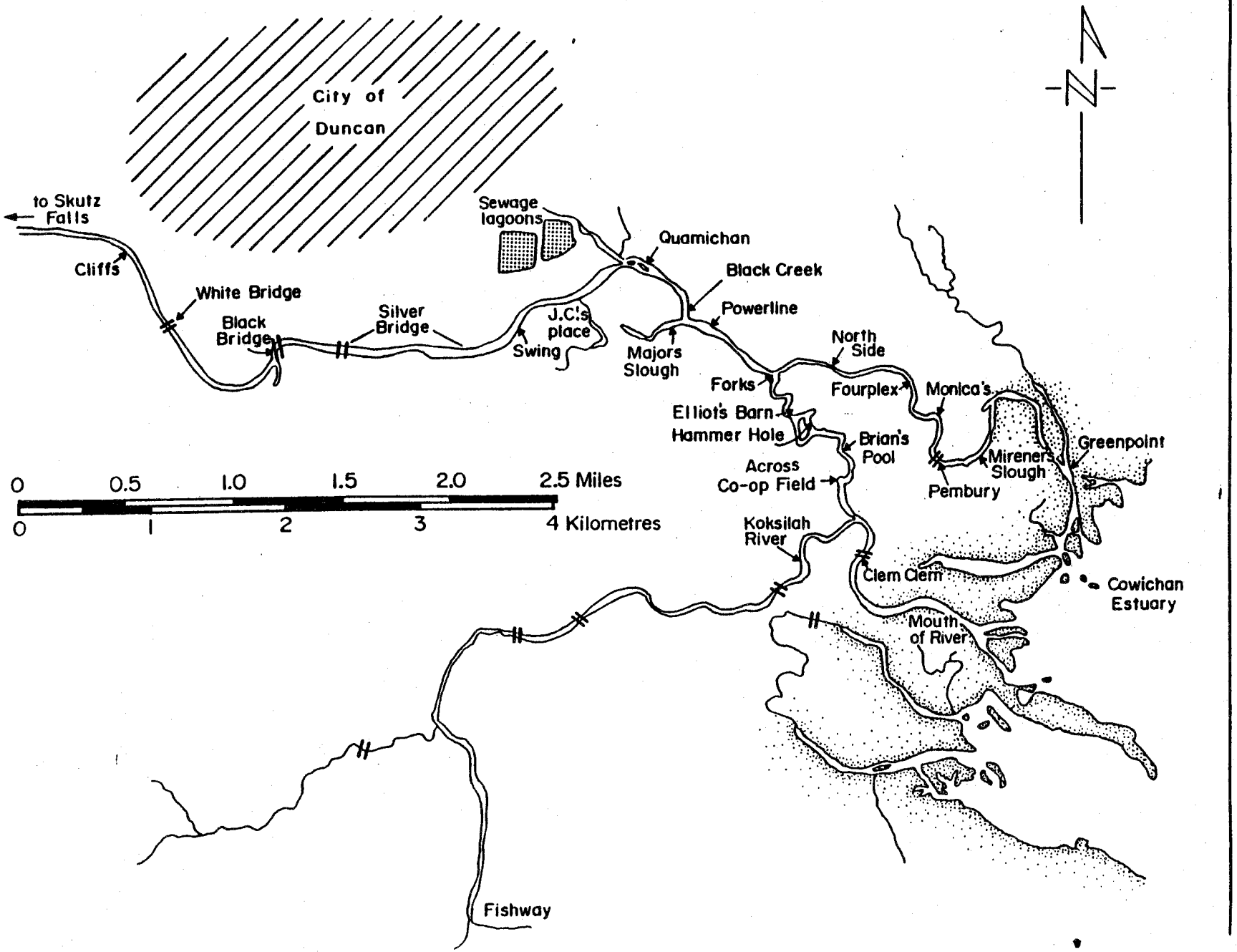
F-Brian's pool to Clem Clem and part of Koksilah

G-Clem Clem to mouth

H-North side to Four plex

I-Four plex to Meriner's slough

J-Meriner's slough to mouth


City of
Duncan
to Skutz
Falls
Cliffs
White Bridge
Black
Bridge
Silver
Bridge
Swing
J.C.'s
place
Sewage
lagoons
Quamichan
Black Creek
Powerline
Majors
Slough
North
Side
Forks
Fourplex
Monica's
Elliot's Barn
Hammer Hole
Brian's
Pool
Across
Co-op Field
Mirener
Slough
Greenpoint
Pembury
0 0.5 1.0 1.5 2.0 2.5 Miles
0 1 2 3 4 Kilometres
Koksilah
River
Clem Clem
Cowichan
Estuary
Mouth
of River
Fishway

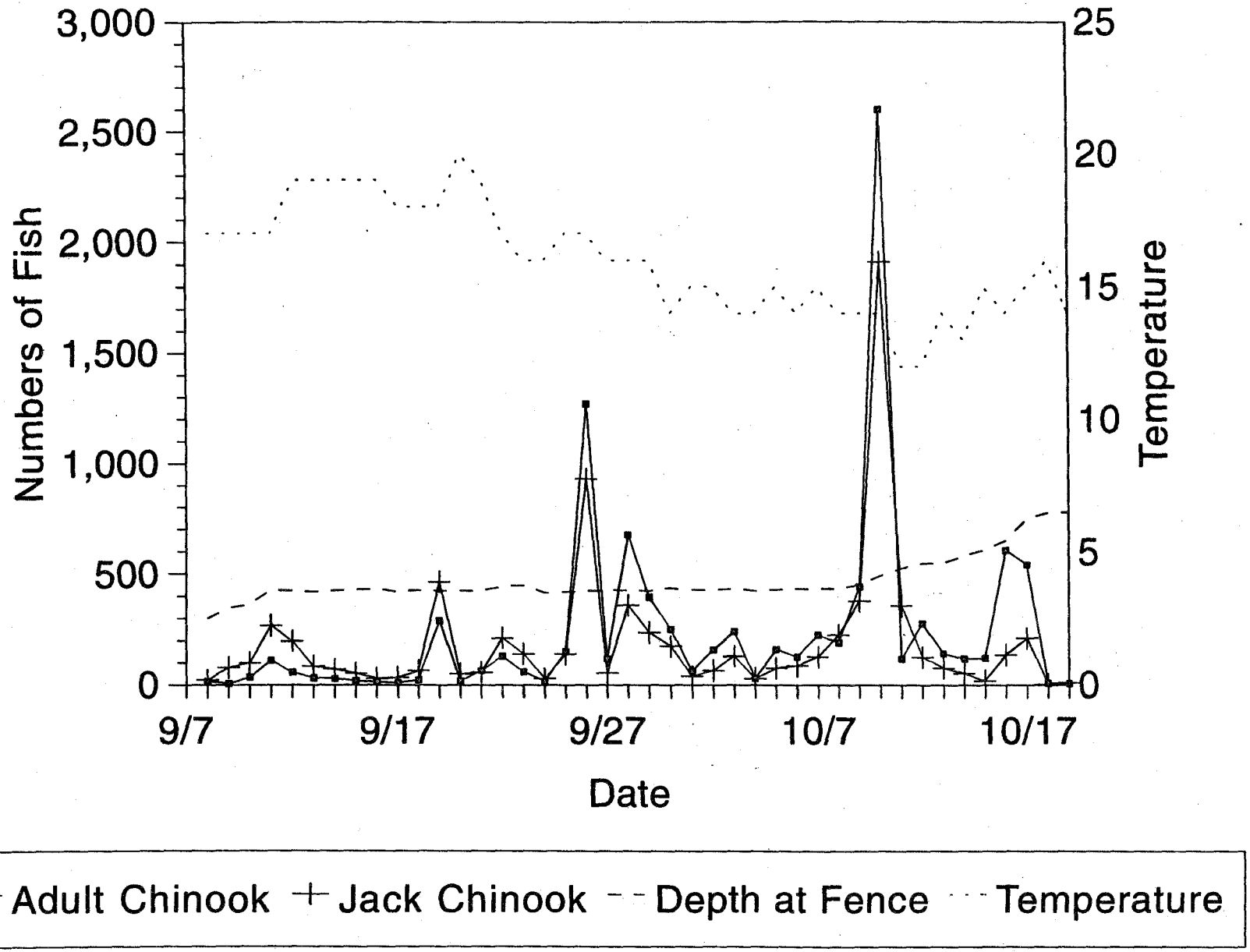


Fig. 3. Daily Chinook Fence Count, 1995

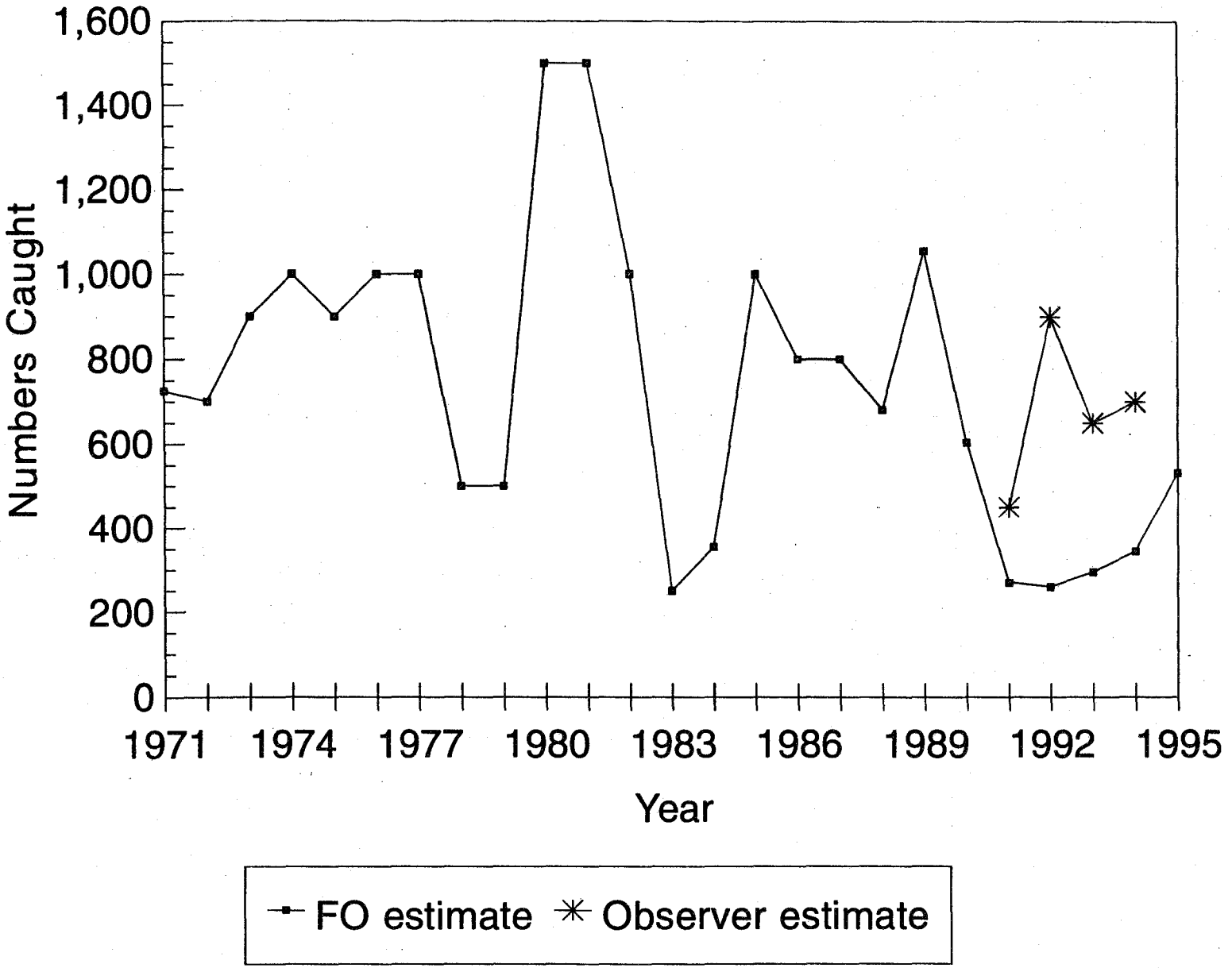


Fig. 4. Native food fishery adult chinook catch data, Cowichan river, 1971-1995.

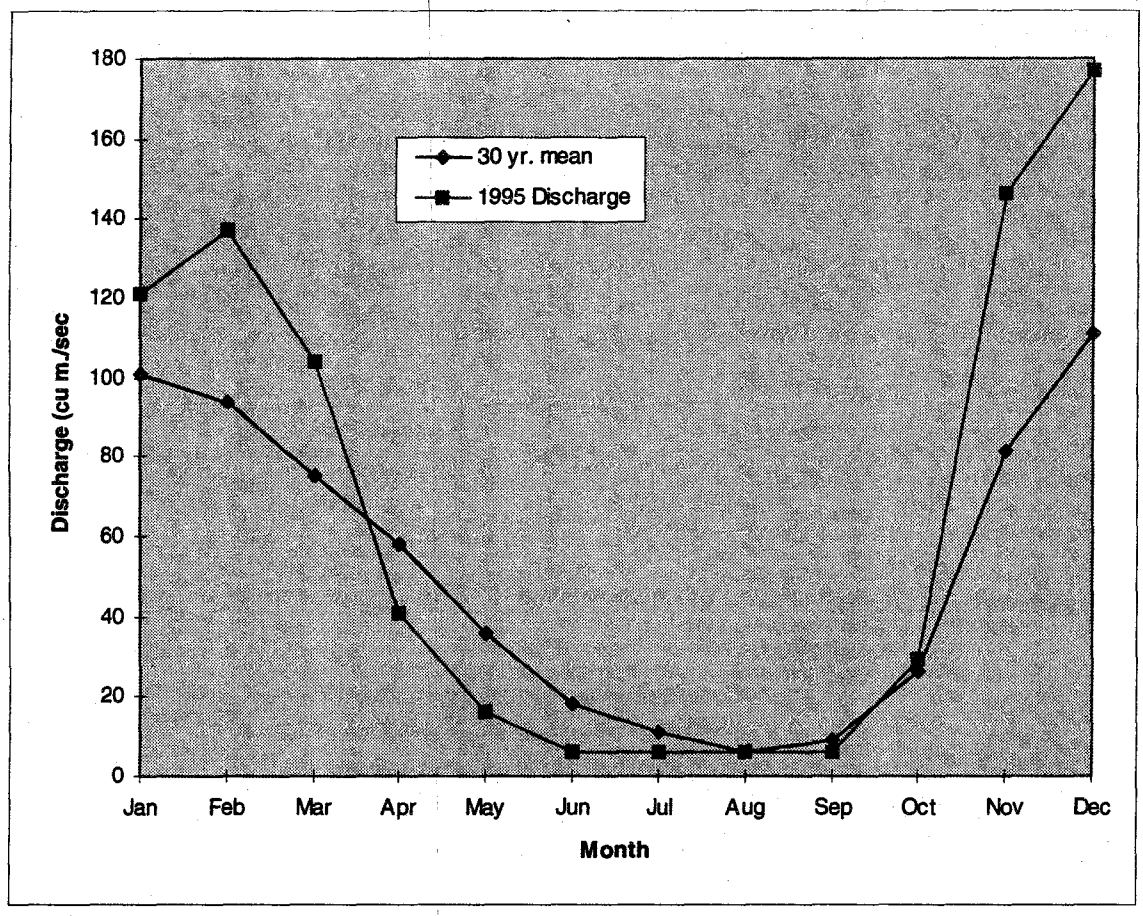


Fig. 5. Cowichan River discharge (cu m/sec), 1995.

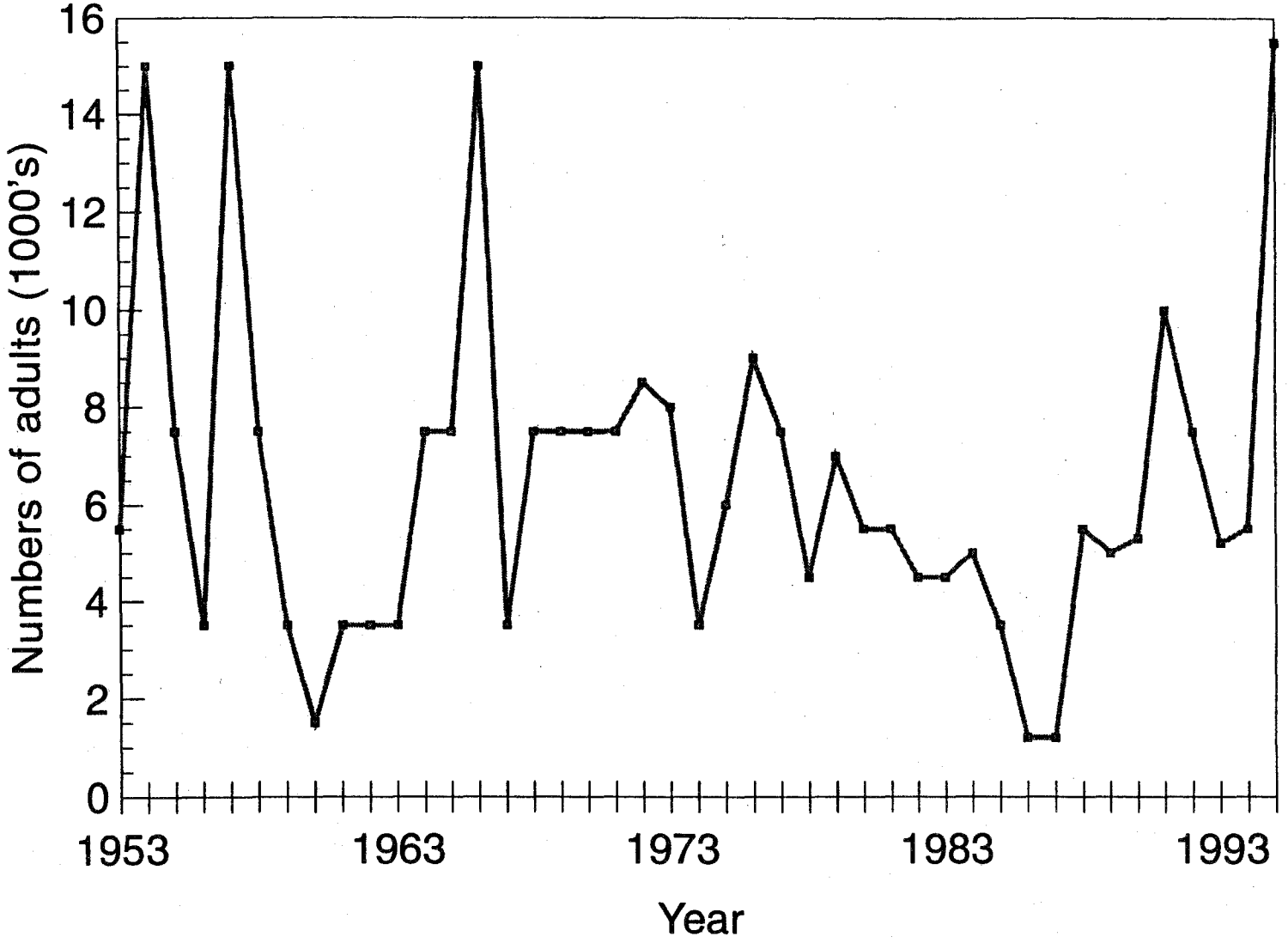


Fig. 6 Adult chinook escapement estimates for the Cowichan River, 1953-1995.
(estimates up to 1988 were based on swim surveys, stream walks, and helicopter flights)
(estimates from 1988 to present were based on fence count and mark-recapture data)

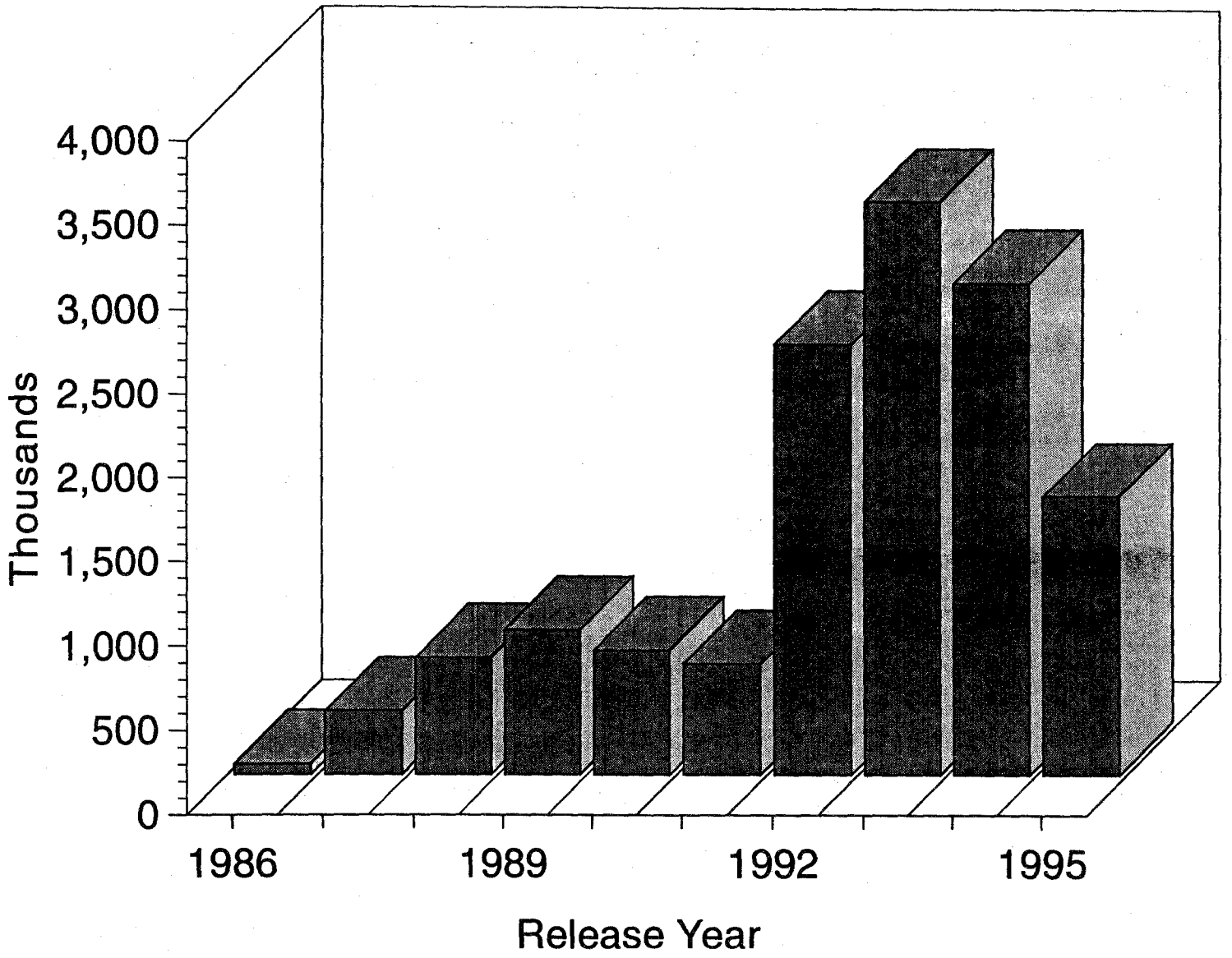


Fig. 7. Hatchery chinook released into the Cowichan system as fry (3 gm) and as pre-smolts (6 gm).