

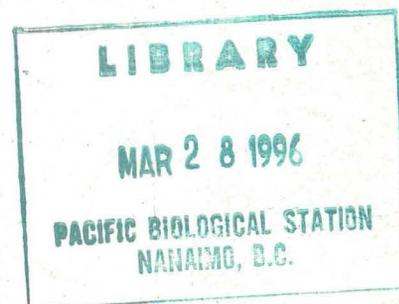


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A Preliminary Report on the Chinook Productivity Study Conducted on the Cowichan River During 1992

D. A. Nagtegaal, J. Candy and B. Riddell

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Pacific Biological Station
Nanaimo, British Columbia
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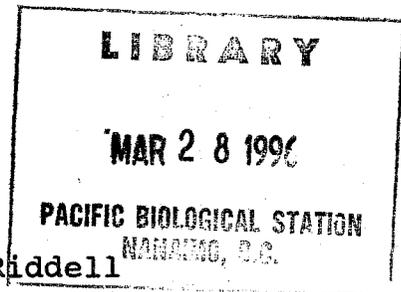
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by

D. A. Nagtegaal, J. Candy and B. Riddell



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ABSTRACT

Nagtegaal, D. A., J. Candy and B. Riddell. 1994. A preliminary report on the chinook productivity study conducted on the Cowichan River during 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2268: 73 p.

In 1992, 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 mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 8,678 in 1992. The total return was determined to be the sum of the fence count, the Native food fish catch, and the numbers of broodstock removed below the fence. The number of natural spawners was estimated as 6,676. These were considered minimum estimates since the enumeration fence was washed out due to high water levels prior to the end of the run. Fishery Officers estimated the adult chinook return to be 7,500. In addition, a water management plan is described which was intended to aid upstream movement of chinook.

RÉSUMÉ

Nagtegaal, D. A., J. Candy and B. Riddell. 1994. A preliminary report on the chinook productivity study conducted on the Cowichan River during 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2268: 73 p.

En 1992, la Direction générale des Sciences biologiques de la Station de biologie du Pacifique a réalisé une étude sur la productivité du saumon quinnat (*Oncorhynchus tshawytscha*) dans la rivière Cowichan. Les principales composantes de l'étude comprennent : i) le dénombrement des géniteurs, ii) l'estimation des prises des autochtones, iii) les prélèvements de géniteurs d'écloserie et iv) l'échantillonnage biologique et la collecte de données par micromarques magnétisées codées. Une étude de marquage-recapture a été effectuée pour compléter le dénombrement. On a estimé à 8,678 le nombre total de saumons quinnats adultes qui ont remonté la rivière Cowichan en 1992. Il a été établi que le nombre total des remontées était égal à la somme des poissons dénombrés à la barrière, des prises des autochtones et du nombre de géniteurs prélevés en aval de la barrière. On a dénombré 6676 géniteurs naturels. Ces estimations sont jugées comme des valeurs minimales, puisque la crue des eaux a emporté la barrière de dénombrement avant la fin de la remontée. Les agents des pêches ont estimé à 7,500 le nombre de saumons quinnats adultes ayant remonté la rivière. De plus, un plan de gestion des eaux a été appliqué par la Direction des pêches de Pêches et Océans Canada dans le but de faciliter la remontée du saumon 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. The Biological Sciences Branch, 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., 1994).

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 2.5 million in 1992. Marked releases began in 1980 and in 1992 approximately 10% of the total number of chinook released were coded-wire tagged (Millerd, pers comm).

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 (5-10 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 productivity study conducted on the Cowichan River during the fall of 1992.

METHODS

Components of the Cowichan River study include: i) enumeration of spawning chinook salmon; 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) a live mark-recapture study for both adult and jack chinook.

A detailed description of the methodology used to collect the above information was presented in Nagtegaal et al. (1994). No major changes were made in 1992.

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

FENCE OPERATION:

In 1992, the counting fence was operated from August 18 through to the end of October (Oct. 31). Due to high water flows and fence failure the operation was terminated somewhat earlier than anticipated. 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. In addition 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:

Eight swim surveys were made by Fishery Officers during 1992 to estimate the spawning population of chinook. These were conducted on Sept. 16, Oct. 2, 15, 27 and 28, and on Nov. 13 in the upper 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. To maintain consistency the same swim team was used for each survey, as often as practicable.

Some duplicate swims were conducted to determine consistency of swim survey counts. Two different swim teams surveyed the same section of river a few hours apart on the same day (Oct. 15 and Nov. 13), and the same swim team surveyed the same section of river on subsequent days (Oct. 27 and 28). It was assumed that there would be no substantial fish movement between

the swim surveys conducted on the same day or those conducted on two subsequent days.

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

NATIVE FOOD FISHERY:

In 1990, a systematic approach was developed by the Cowichan Band to estimate the native food fish catch as well as manage the fishery more closely (Paige, Unpubl.). This approach involved the recording of 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 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.

BIOLOGICAL DATA:

Biological data for chinook were to be collected from four sources: i) hatchery broodstock samples; ii) enumeration fence; iii) mark/recapture (spawning ground); and iv) native food fishery. Hatchery staff collected biological data and recorded the incidence of CWT tagged fish from the chinook broodstock. A random sample of chinook going through the trap at the enumeration fence was sampled for length, sex, scale, and checked for missing adipose fin from the beginning, middle and end of the run. The goal was to sample approximately 25% of the chinook run. Chinook were sampled for length, sex, scale, presence/absence of fence tag, and adipose clip on a daily basis on the spawning grounds.

A member of the Cowichan Indian Band was hired to collect biological data from the Native food fishery for chinook. The person monitored both the traditional spear fishery as well as the in-river gillnet fishery. Data for length, sex, scale and adipose clip rate were recorded by management zone on a daily basis. The person interviewed as many fishermen as possible and attempted to sample fish from all management zones. Due to concentrated fishing effort in certain zones and lack of cooperation from some fishermen, not all areas were sampled equally.

MARK-RECAPTURE:

The mark/recapture program involved tagging chinook jacks and adults at the enumeration fence and their subsequent recovery on the spawning grounds. This was intended to provide an independent estimate of escapement to augment the fence count and swim survey estimate. Chinook were individually dipnetted out of the fish trap, tagged with a Ketchum¹ aluminum sheep ear tag on the operculum, and immediately released. Fish were placed in a quiet pool just above the trap to allow for recovery. Essentially all fish tagged were in good condition at release since those fish that were considered to be in rough shape were not tagged. Length, sex, and adipose clip information was recorded for all tagged fish. Opercular punch was used as a secondary tag on some chinook.

A two man crew in an inflatable boat daily surveyed the upper river (Fig. 1) and collected all available spawned chinook carcasses. This section of the river above Skutz Falls represents the area where the majority of spawning occurs. The middle river (Skutz Falls to the fence) was surveyed weekly for carcasses. For each fish sampled the location, length, sex, and presence/absence of the adipose fin, spawning condition, and tag number were recorded and the tail cut off to prevent recounting. 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 to sample.

POPULATION ESTIMATE:

Adult chinook salmon escapement was calculated from the mark-recapture data using both simple (Chapman modification) and stratified Petersen formula (Schaefer method) for the Cowichan system (Ricker 1975).

A) Simple Petersen:

1) Estimated total chinook escapement (N_t):

$$N_{(t)otal} = N_{(m)ales} + N_{(f)emales}$$

¹Ketchum Manufacturing Ltd., Ottawa, Canada.

Where:

$$N = \frac{(M + 1) (C + 1)}{(R + 1)}$$

(calculated separately for both males and females)

2) Estimated 95% confidence limits of N_t :

$$N_t \pm 1.96 \sqrt{V_t}$$

Where:

N_t = total escapement estimate

V_t = variance of escapement estimate;

$$= \frac{(N^2) (C - R)}{(C + 1) (R + 2)}$$

(calculated separately for both males and females)

C = number of adult carcasses examined for tags
(opercular tags and punches)

R = number of tagged or secondary marked adult carcasses
recovered

B) Stratified Petersen:

1) Estimated total chinook escapement (N_t):

(time of marking was divided into periods designated by i,
and time of recovery into periods designated by j, where each
period represents one week)

$$\text{Where: } N_t = \sum N_{ij} = \sum \left(R_{ij} \times \frac{M_i}{R_i} \times \frac{C_j}{R_j} \right)$$

in which:

M_i is the number of adults marked in the ith period of
marking

C_j is the number of adults examined in the j th period of recovery

R_{ij} is the number of adults marked in the i th period which are recovered in the j th period

R_i is the total recaptures of tagged adults in the i th period

R_j is the total recaptures of tagged adults in the j th period

2) Estimated 95% confidence limits of N_i :

The upper and lower 95% confidence limits for the estimate were obtained using fiducial limits for the Poisson distribution. These were calculated by substituting the observed number of adult recaptures for the unknown term (X) in E. S. Pearson's formula;

$$X + 1.92 \pm 1.96 \sqrt{X + 1.0} ,$$

and then substituting the results into the formula for N_i above (Ricker 1975, Seber 1982).

RESULTS

ENUMERATION FENCE:

Daily counts at the enumeration fence are contained in Table 1, Fig. 3. Total counts recorded during this period were: 7,740 adult chinook; 3,694 jack chinook; 4,062 adult coho; 1,569 jack coho; 1,212 chum and 3 unidentified salmon.

During the season, jacks tended to enter the river earlier than adult chinook. Daily counts were summarized by one hour intervals (Table 2) and we note that peak movement of adult chinook occurred between 0700 and 1000 in the morning and jack chinook between 1700 and 1900 in the evening.

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 67 fish examined, no errors were recorded.

SWIM SURVEYS:

A summary of visual surveys from 1981-1991 is presented in Table 3. Total escapement estimates for each year are for adult chinook only. The 1992 escapement of adult chinook was estimated by Fishery Officers to be 4500 based on the swims made during the season. All swim surveys were conducted under good conditions and no major difficulties were encountered. Since the flow remained quite low a survey was made in November. It was assumed that the final swim on Nov. 13 was made after peak spawning and included a count of carcasses.

At the end of the season, based on some observations of the fish holding in the large pool below the fence and after reviewing the fence count, Fishery officers adjusted the escapement estimate to 7500 (T. Fields, pers comm). It was understood that due to low water conditions, substantial numbers of chinook did not spawn in the upper end of the river, and consequently were not observed in the swim surveys.

Comparison of multiple swim survey data (Appendix Table 1) indicated that using the same swim team would likely provide more consistency in spawner counts than using different swim teams. Adult chinook counts by swim team were compared by examining cumulative proportions of numbers of fish (Zar, 1984) by pool/riffle recorded by each swim team. No significant differences were detected (Kolmogorov-Smirnov; $D_{obs} < D_{alpha}$) for results from the same swim team adult chinook counts or between different swim team counts. This indicates that although total counts were quite dissimilar, the proportion of fish recorded by pool/riffle was not significantly different. The most comparable total counts of adult and jack chinook were recorded when the same team swam the same section of river on two consecutive days. These results are based on very limited data but do compare favourably to the results from other studies (Shardlow et. al., 1987)

NATIVE FOOD FISHERY:

Estimates of the native food fish catch of chinook for 1992 are listed in Table 4. The catch estimate was determined by the River Management Unit of the Cowichan Indian Band (Wayne Paige, pers comm.). The adult chinook catch estimate was one of the

lowest in recent years even though optimal fishing conditions prevailed (John Charlie, pers comm). Based on the Indian food fish sampling program an estimated 850 to 950 adult chinook were taken in the fishery (John Charlie, pers comm). It was very difficult to assess the quality of the data collected from either of these sources but it was apparent that some discrepancies continue to exist as in previous years.

HATCHERY COMPONENT:

In 1992, 1850 chinook were removed from the river, of which 51% were collected at the enumeration fence (Tables 5 and 6). A summary of broodstock collection for 1981-1992 is contained in Table 7. Primarily 3 and 4 year old chinook were used for broodstock (Table 8).

BIOLOGICAL DATA:

During 1992, 2435 adult and 629 jack chinook were sampled at the enumeration fence site for adipose marks, approximately 30% of the estimated run. The mark rate for males was 8.2%, for females was 4.3%, and for jacks was 3.7% (Table 9).

An estimated 20% of the Indian food fish catch was examined (Table 10). The majority of the chinook taken in the food fishery were 3 and 4 year olds (Table 11) and twice as many female chinook were caught than males. This was likely due to the fact that the fishery targets on the earlier part of the run, since females tend to enter the river earlier than the adult males.

Table 12 lists the size frequency of chinook tagged at the counting fence. Table 13 contains a length-frequency summary of chinook sampled on the spawning grounds. The majority of chinook sampled on the spawning grounds were 4 year olds (Table 14). Considerably more adult females were recovered on the spawning grounds than males.

Length-frequency summaries of chinook broodstock collected and sampled at the hatchery are listed in Table 15. The hatchery staff randomly samples approximately 25% of all broodstock and then selectively samples all remaining marked chinook. The adipose mark rate was 1.6% for males, 29.2% for jack chinook, and 20.3% of the females were marked. The mark rate from hatchery samples was substantially different from data collected at either the fence or from the spawning grounds. Coded-wire tag (CWT) recovery information for chinook sampled on the spawning ground is listed in

Appendix Table 2 and for the Native food fishery in Appendix Table 3. Approximately 54% of the recovered fish were from the late hatchery release group.

WATER RELEASE STUDY:

The release of additional water stored in Lake Cowichan occurred on September 27 at noon. Water temperature and stage were monitored at the counting fence (Table 16) and discharge at the Water Survey Canada recording station at the Island highway in Duncan (Table 17). Note that with the increased flow a corresponding increase in the daily chinook count occurred (Fig. 4). No other water releases were scheduled since there wasn't sufficient storage (T. Fields, pers comm).

MARK-RECAPTURE:

Table 18 summarizes the tagging data for chinook at the fence and Table 19 lists the recovery data for chinook sampled on the spawning grounds. Both tagging (Aug.26-Oct.30) and recovery (Oct.26-Nov.27) were spread over several weeks during peak migration and spawning. In 1992, 1283 adult and 484 jack chinook were tagged. Only 15 tagged males, 67 tagged females, and 7 tagged jack chinook were recovered out of 1280 fish sampled on the spawning grounds. Approximately one-third (28%) of the tagged fish recovered had lost their tag but had an obvious mark on the operculum indicating that a tag had been applied. Only three secondary tagged jack chinook were recovered on the spawning grounds of the 209 females, 168 males, and 201 jacks tagged at the fence.

Twenty-two tagged jack chinook, 3 females and 2 males (1% of total fish tagged) were recovered on the fence that had presumably died from tagging. Most of these fish died during the early part of the run when low warm water conditions existed. Initial mortality due to the tagging procedure must have been low otherwise more tagged chinook would have ended up dead on the enumeration fence. The only measure of longer term mortality was the number of tagged pre-spawn mortalities recovered on the spawning grounds. Only four tagged female chinook, representing less than 1% of the fish examined, were recovered on the spawning grounds that had died before spawning.

PETERSEN POPULATION ESTIMATE:Simple Petersen:

The escapement of chinook adults calculated from the mark-recapture data was 15,346, with lower and upper 95% confidence limits of 13,734 and 16,958. The escapement of male and female chinook was 8,994 and 7,985, respectively (Table 20).

Stratified Petersen:

The total adult escapement estimate using the Schaeffer method was calculated to be 7,230, with lower and upper 95% confidence limits of 4,305 and 10,798 (Table 21). Estimates could not be calculated by sex using this method since too few tagged fish were recovered during each recovery period.

Potential biases:

Some of the typical biases associated with mark-recapture experiments (Ricker 1975) are listed below and were examined in some detail.

1. Temporal bias:

Temporal bias in the tagging sample was examined by comparing the mark incidence between periods in the recovery sample (Table 22). Mark incidence was significantly higher during the first two weeks ($P < 0.05$; chi-square). For the purpose of comparison the data from the first and last weeks of recovery were combined with data from the adjacent week, since sample sizes were quite small.

Recovery bias was examined by stratifying the application sample by period and comparing proportions recovered (Table 23). Since sample sizes were small the first three application periods were combined. No significant differences were observed ($P > 0.05$; chi-square).

2. Location bias:

Spatial bias in the application sample was examined by comparing the mark incidence between the upper and lower river sections in the recovery sample (Tables 24 and 25). There was very little difference between the upper and lower sections of the river ($P > 0.05$; chi-square). Recovery bias was not examined since all fish were tagged at the enumeration fence.

3. Fish size:

Size related bias in the application sample was examined by comparing the continuous POH length frequency distributions of marked and unmarked recoveries from the spawning ground (Table 12 and 13). No significant differences were observed in males ($P > 0.05$; Kolmogorov-Smirnov two sample test), but more large females were tagged than recovered. Size related bias in the recovery sample could not be examined since all fish that were captured at the fence were either taken for broodstock or tagged and released.

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 26). 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, the proportion of females was significantly higher than either males or jacks ($P < 0.05$; 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 limited information regarding the numbers that entered before or after the fence was in operation. In 1992, no swim survey was available to estimate the chinook in the river prior to Aug. 18, and only one swim survey was conducted after the fence was washed out on Oct. 31. The fence count suggests that the run was not completely over but had certainly slowed since fewer numbers of chinook were passing by the fence during the last days of operation. The numbers of fish recorded at the fence should be considered an incomplete count of the total run, but likely the most accurate count available for that time period (Cousens et. al., 1982; Johnston et. al., 1986).

This 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 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 being shed were the main causes of fence failure. This remains an ongoing problem that is very difficult to overcome.

SWIM SURVEY DATA:

Among the biases typically associated with swim surveys, the procedure used by Fishery Officers to extrapolate 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, the swim survey results tend to overestimate total escapement (Nagtegaal et al., in press). The results of the 1992 swim surveys support the hypothesis that during low water flow conditions in late fall, the swim survey results tend to underestimate the number of spawners. Since survey counts and Fishery officer expanded estimates were significantly less than the fence count over the same time period, the swim survey information was assumed to have substantially underestimated total escapement (Fig. 5).

Low flow conditions tend to underestimate the numbers of spawners because of different spatial distribution of spawners during these years. That is, not as many fish make it above Skutz Falls to the traditional spawning areas in low water years. As a result the swim surveys conducted in these areas 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. It may be helpful to incorporate water flow conditions into the expansion factor used by Fishery officers.

NATIVE FOOD FISHERY:

Since we did not have the opportunity to directly assess catch estimation procedures used by the River Management Unit, no comments could be made regarding the methodologies used. The 1992 catch estimate of 260 adult chinook seemed to be quite low relative to the fence count, the prevailing fishing conditions and based on our observer sampling information. The biological observer sampled 228 adult chinook and 20 jacks and estimated that he had monitored approximately 20% of the total catch (John Charlie, pers. comm.). On this basis, he estimated the total food fish catch to be approximately 850-950 adults. At best, these two estimates could

be considered to be the upper and lower range of the actual food fish catch.

BIOLOGICAL DATA:

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 at the counting fence (9.7%-males; 5.4%-females) was similar ($P > 0.05$, chi-square) to the mark rate of chinook recovered on the spawning grounds (10.1%-males; 6.5%-females), but significantly different ($P < 0.05$, chi-square) than the hatchery broodstock sample collected at and below the fence (1.6%-males; 20.3%-females). Cumulative frequency distributions were also compared by sex between hatchery, fence and spawning ground samples for adult chinook. Significant differences ($D_{obs} > D_{alpha}$; Kolmogorov-Smirnov) between hatchery and fence samples were detected for both sexes and between males from the hatchery sample and the spawning ground. No significant differences ($D_{obs} < D_{alpha}$) were found between females from the hatchery sample and the spawning ground. A broader size range for both sexes was sampled at the fence and on the spawning ground than those fish selected for broodstock by the hatchery. 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 spawned adipose-clipped fish are selectively sampled for production assessment purposes. No definite conclusions could be made concerning this discrepancy, however, these differences have been noted in previous years as well (Nagtegaal et al., in press).

WATER RELEASE STUDY:

Weather conditions, water temperature and flow rate all affect the timing of migration of spawning salmon. A cursory look at the enumeration data suggests that the release of stored lake water contributed to the upstream movement of chinook. The 1992 results were positive since considerable increases in upstream movement of chinook were recorded during and after the water release. The weather had been warm and dry for some time prior to the release. To what extent the weather conditions contributed to the effect of the water release on upstream movement is unknown.

MARK-RECAPTURE:

Recovery of tagged fish on the spawning ground again posed a considerable problem on the Cowichan River (Nagtegaal et al., in press). The main spawning area in the upper section of the river consists of a series of riffles and deep pools. When the flow is less than 750 CFS, carcasses can quite easily be recovered, but when flows are higher (which typically occurs at peak spawning due to fall rains) the water becomes turbid and the carcasses tend to disappear into the deep pools. Even though an extensive carcass recovery program was implemented and weather/water flow conditions were good, few tagged chinook were recovered.

Possible reasons for the low recovery rate could be tag loss, and/or a high rate of tag related mortality. If tag loss was the primary cause, we should have observed considerably greater numbers of fish on the spawning grounds that had an obvious notch in the operculum indicating where a tag used to be. If high tag related mortality was the cause then we should have observed more tagged mortalities at the fence and more pre-spawning mortalities on the spawning grounds. Neither of these situations occurred. More study will be required to further investigate these problems.

The Petersen estimate using Schaeffer's method compared more favourably with the fence estimate of spawners than the simple Petersen estimate. This indicates that stratification is essential in providing reasonable estimates in a river such as the Cowichan. Although some biases in the tag application and recovery of carcasses were identified, it was assumed that these would not likely bias the escapement estimate.

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. Based on these data, consumption of chinook salmon could range from 500 to 1500 adults. This data was 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 move upstream.

ESCAPEMENT ESTIMATE:

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 Indian food fishery. On this basis we calculate the total return to the Cowichan River from Aug. 18 -Oct. 31, 1992 to be 8678 (Table 27). This is a minimum estimate since these numbers are based on the fence count and assumes that no chinook were in the river prior to or after the counting fence was in place. Since the fence was washed out prior to the end of the run, we estimate 500 to 1000 chinook may have entered the river after the fence operation was terminated. If we include the observer estimate for the Native food fish catch and a seal predation estimate of 1200, then it is probable that the total return of chinook in 1992 was closer to 11,000 adults. The number of natural spawners was calculated to be 6676 (Table 27). This was based on the fence count minus the chinook adults removed for broodstock at and above the fence.

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Table 1. Daily counts at the enumeration fence site, 1992

Date	Chinook		Coho		Chum	Unknown ¹
	Adult	Jack	Adult	Jack		
Aug. 18	0	0	0	0	0	0
19	1	1	0	0	0	0
20	0	0	0	0	0	0
21	0	2	0	0	0	0
22	1	1	0	0	0	0
23	0	1	0	0	0	0
24	1	1	0	0	0	0
25	0	7	0	0	0	0
26	1	1	0	0	0	0
27	0	3	0	0	0	0
28	1	6	0	0	0	0
29	3	4	0	0	0	0
30	3	2	0	0	0	0
31	2	1	0	0	0	0
Sept. 01	16	9	0	0	0	0
02	29	10	3	0	0	0
03	61	11	3	1	0	0
04	4	6	0	0	0	0
05	6	2	0	0	0	0
06	43	5	1	0	0	0
07	3	1	0	0	0	0
08	5	3	0	0	0	1
09	4	3	0	0	0	0
10	0	2	0	0	0	0
11	29	20	0	0	0	0
12	0	1	0	0	0	0
13	3	4	0	0	0	0
14	1	5	0	0	0	0
15	7	8	0	0	0	0
16	2	9	0	0	0	0
17	3	9	0	0	0	0
18	0	8	0	0	0	0
19	2	7	0	0	0	0
20	3	13	0	0	0	0
21	7	20	0	0	0	0
22	30	11	0	0	0	0
23	45	6	0	0	0	0
24	59	59	0	0	0	0
25	19	10	0	1	0	0
26	20	13	0	1	0	0
27	14	8	0	0	0	0
28	142	33	1	1	0	0
29	153	39	1	2	1	0
30	55	19	3	2	0	1
Oct. 01	179	17	8	4	0	0
02	55	9	1	0	0	0
03	90	16	9	3	0	0

Table 1 (cont.)

Date	Chinook		Coho		Chum	Unknown
	Adult	Jack	Adult	Jack		
Oct. 04	132	3	3	1	0	0
05	317	10	5	6	2	0
06	23	2	2	0	0	0
07	40	0	2	0	0	0
08	13	8	0	5	0	0
09	30	3	2	0	1	0
10	14	7	1	1	0	0
11	88	26	3	3	0	0
12	28	11	5	4	1	0
13	38	4	5	2	3	0
14	10	7	1	2	2	0
15	10	8	0	1	0	0
16	23	16	3	1	1	0
17	53	24	6	1	1	0
18	123	60	4	2	2	0
19	956	574	19	48	4	0
20	1032	930	13	38	5	0
21	530	360	14	20	2	1
22	89	57	19	15	10	0
23	1251	632	909	380	99	0
24	486	164	664	191	199	0
25	790	177	348	267	270	0
26	40	32	137	21	23	0
27	157	73	466	185	158	0
28	148	16	509	172	163	0
29	109	47	496	142	119	0
30	108	17	391	46	144	0
31	0	0	5	0	2	0
Total:	7740	3694	4062	1569	1212	3

¹ Unidentified salmon

Table 2. Daily counts¹ by time interval at the enumeration fence site, 1992

Time	Adult No.	Chinook		Jack No.	%
		%			
0000-0100	91	1		36	1
0100-0200	151	2		85	2
0200-0300	298	4		125	3
0300-0400	300	4		135	4
0400-0500	330	4		114	3
0500-0600	287	4		85	2
0600-0700	305	4		87	2
0700-0800	328	4		128	3
0800-0900	710	9		172	5
0900-1000	764	10		324	9
1000-1100	463	6		184	5
1100-1200	327	4		103	3
1200-1300	298	4		102	3
1300-1400	369	5		179	5
1400-1500	278	4		123	3
1500-1600	354	5		192	5
1600-1700	290	4		168	5
1700-1800	496	6		355	10
1800-1900	455	6		408	11
1900-2000	292	4		252	7
2000-2100	201	3		164	4
2100-2200	121	2		69	2
2200-2300	118	2		63	2
2300-2400	114	1		41	1

¹Summary of fence count data

Table 3. Visual survey data collected for the Cowichan river by fishery officers stationed in the Duncan subdistrict.

Method ¹	Date	Chinook				River Segment ²
		Jacks		Adults		
		Count	Estimate	Count	Estimate	
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
Total 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	
Total 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
Total 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
Total 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
Total for Season					3500	

Table 3. (cont.)

	Method ¹	Date	Chinook				River Segment ²
			Jacks		Adults		
			Count	Estimate	Count	Estimate	
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
Total 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
Total 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
Total 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
Total 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
Total for Season						5300	

Table 3. (cont.)

Method ¹	Date	Chinook				River Segment ²	
		Jacks		Adults			
		Count	Estimate	Count	Estimate		
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
Total 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
Total for Season						7500 ⁶	

¹S - Swim survey, H - Helicopter survey, F - boat survey

²Refer to Fig. 1

³Total escapement estimate for adult chinook

⁴516 chinook carcasses were counted in this total

⁵28 chinook carcasses were counted in this total

⁶Fishery officer escapement estimate based on swim survey results was 4500, but after reviewing the fence count the escapement was determined to be 7500 adults.

Table 4. 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 ³	260	12

¹Includes legally caught chinook from the native spear fishery and the in-river gillnet fishery only.

²Since 1988 data collected by Cowichan Native Band River Management. Prior to 1988 data was collected by the local fishery officers

³A biological observer hired by DFO estimated that between 850 and 950 chinook were taken in the native food fishery.

Table 5. Broodstock collection¹ for the Cowichan hatchery, 1992

Date	Below fence			At fence			Above fence		
	M	J	F	M	J	F	M	J	F
Sept. 28				19	1	24			
29				52	7	54			
30				16	0	19			
Oct. 1				49	7	79			
2				19	2	23			
3				46	1	41			
4				44	0	63			
5				86	0	109			
6				55	3	55			
7				22	0	14			
8	26	14	26	7	1	6			
9	47	5	83	6	1	12			
10	66	28	135						
12	101	8	194						
22							2		2
26							7		11
27							0		10
28							3	2	12
29							1	1	9
30							17	14	12
Nov. 2							4	1	9
3							6	2	20
4					5		1	2	2
5							5	1	11
6							4	1	4
9								1	1
Totals:	240	55	438	421	28	499	50	25	94

¹Based on hatchery records

Table 6. Summary of chinook broodstock collected¹ at the enumeration fence, 1992

Date (dd/mm)	Male		Female		Jacks	
	Clip ²	Noclip	Clip	Noclip	Clip	Noclip
28/09	1	30	0	46	0	0
29/09	5	33	5	29	0	0
30/09	2	15	0	22	0	0
01/10	4	61	2	66	2	1
02/10	3	17	2	27	0	0
03/10	2	36	0	61	1	0
04/10	2	34	5	64	0	0
05/10	11	137	0	100	0	0
06/10	0	21	0	32	0	1
07/10	1	24	0	12	0	0
08/10	1	4	0	6	1	1
09/10	1	5	0	12	0	0
Total:	33	417	14	477	4	3

¹Based on counting fence records²adipose fin clipped chinook

Table 7. Adult chinook escapement used for hatchery broodstock, Cowichan river¹.

Year	No. of fish collected
1981	282
1982	534
1983	242
1984	278
1985	175
1986	315
1987	582
1988	678✓
1989	535✓
1990	327 326 + 1
1991 ²	1755 × 1595 A + 444 jacks
1992	1850 × 1742 H + 108 jacks

¹Barry 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 subtracted from the broodstock numbers provided to give an estimate of the number of adult chinook removed from the system.

²In addition, 284 males were removed for broodstock but never used and later returned to the river.

Table 8. Summary of chinook broodstock age data¹, 1992

Age	Chinook		
	Males	Females	Total
2	18	0	18
3	26	24	50
4	38	119	157
5	-	2	2
Total	82	145	227

¹Data from random sample of chinook broodstock collected by Cowichan Hatchery.

Table 9. Summary of chinook sampled¹ at the enumeration fence, 1992

	Male	Female	Jacks
Sampled:	1094	1341	629
Adipose clip:	90	58	23
Adipose clip (%):	8.2	4.3	3.7

¹Random sample taken from the beginning, middle and end of the run, including tagged and untagged chinook

Table 10. Length-frequency of chinook sampled from the Indian food fishery, 1992

Length (cm)	Chinook			Total
	Males	Females	Jacks	
38			2	2
39			1	1
40			1	1
41			2	2
42			0	0
43			2	2
44			2	2
45	2	1		3
46	1	0		1
47	0	0		0
48	0	0		0
49	1	1		2
50	0	0		0
51	1	0		1
52	1	0		1
53	0	0		0
54	2	0		2
55	0	0		0
56	1	0		1
57	0	2		2
58	1	0		1
59	1	2		3
60	2	1		3
61	3	1		4
62	3	5		8
63	1	1		2
64	4	2		6
65	3	5		8
66	3	5		8
67	6	7		13
68	4	11		15
69	3	13		16
70	3	10		13
71	1	15		16
72	3	11		14
73	1	6		7
74	0	14		14
75	5	8		13
76	2	6		8
77	5	9		14
78	5	3		8
79	4	4		8
80	3	7		10

Table 10 (con't)

Length (cm)	Chinook			
	Males	Females	Jacks	Total
81	0	3		3
82	0	3		3
83	0	1		1
84	2	2		4
85	1	0		1
Total:	78	159	10	247
Adipose clip:	7	13	5	
Mark rate (%):	8.9	8.2	50.0	

Table. 11. Summary of the age data collected for chinook sampled during the Native food fishery on the Cowichan R., 1992

Age	Males	Females	Total
2	14	1	15
3	22	21	43
4	33	87	120
5	0	2	2
Total:	69	112	181

Total number of regenerate scales read: 43

Table 12. Length-frequency of chinook tagged at the enumeration fence, 1992

Length (cm.)	Males	Jacks	Females
25	0	1	0
26	0	0	0
27	0	1	0
28	0	0	0
29	0	2	0
30	0	6	0
31	0	5	0
32	0	18	0
33	0	19	0
34	0	21	0
35	0	21	0
36	0	24	0
37	0	30	0
38	0	43	0
39	0	67	0
40	0	60	0
41	0	33	0
42	0	77	0
43	9	24	1
44	9	14	3
45	19	12	6
46	13	9	1
47	19	3	9
48	24	1	1
49	15	1	5
50	19	1	6
51	13	1	4
52	16	1	5
53	9	0	2
54	11	0	2
55	6	0	1
56	10	0	6
57	4	0	3
58	7	0	2
59	2	0	7
60	17	0	11
61	10	0	6
62	14	0	14
63	14	0	13
64	8	0	15
65	10	0	20
66	16	0	17
67	12	0	19
68	11	0	19
69	13	0	28
70	18	0	37

Table 12 (con't)

Length (cm.)	Males	Jacks	Females
71	11	0	27
72	19	0	63
73	10	0	62
74	14	0	35
75	9	0	41
76	11	0	26
77	11	0	12
78	10	0	28
79	6	0	21
80	18	0	52
81	9	0	12
82	8	0	26
83	7	0	10
84	3	0	26
85	2	0	11
86	1	0	2
87	3	0	5
88	1	0	3
89	1	0	3
90	1	0	2
91	1	0	3
92	2	0	1
93	2	0	3
94	1	0	1
95	1	0	0
96	1	0	0
97	2	0	1
98	0	0	1
99	0	0	1
Total:	513	495	741
Adipose clips:	50	18	40
Mark rate (%):	9.7	3.6	5.4

Table 13. Length-frequency of chinook sampled on the spawning grounds, 1992

Length (cm.)	Males	Jacks	Females
28	0	1	0
29	0	0	0
30	0	7	0
31	0	6	0
32	0	13	0
33	0	18	0
34	0	24	0
35	0	41	0
36	0	26	0
37	0	24	0
38	0	27	0
39	0	18	0
40	0	18	0
41	0	18	0
42	0	20	0
43	0	5	0
44	2	9	0
45	2	9	1
46	2	4	0
47	7	1	1
48	4	0	0
49	5	1	0
50	3	1	0
51	7	0	1
52	2	0	1
53	6	0	0
54	7	0	2
55	9	0	2
56	5	0	4
57	12	0	8
58	12	0	11
59	11	0	13
60	13	0	25
61	8	0	14
62	9	0	26
63	12	0	38
64	8	0	31
65	8	0	54
66	14	0	52
67	10	0	48
68	8	0	67
69	10	0	62
70	8	0	55
71	6	0	40
72	14	0	45
73	10	0	27

Table 13 (con't)

Length (cm.)	Males	Jacks	Females
74	5	0	25
75	6	0	19
76	2	0	15
77	1	0	7
78	6	0	13
79	4	0	10
80	2	0	4
81	1	0	1
82	1	0	0
83	2	0	0
84	1	0	0
85	1	0	0
86	0	0	0
87	0	0	0
88	0	0	1
Total:	266	291	723
Adipose clips:	27	28	47
Mark rate (%):	10.1	9.6	6.5

Table 14. Summary of chinook age data collected on the spawning grounds, 1992.

Age	Males	Females	Total
2	186	12	198
3	84	58	142
4	84	363	447
5	3	14	17
Total:	358	447	805

Total number of regenerate scales read: 235

Table 15. Length-frequency of chinook broodstock¹ collected for the Cowichan R. hatchery, 1992

Length (cm.)	Males	Jacks	Females
29	0	1	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	0
34	0	1	0
35	0	2	0
36	0	2	0
37	0	1	0
38	0	3	0
39	0	2	0
40	0	0	0
41	0	1	0
42	0	3	0
43	0	2	0
44	0	1	0
45	0	0	0
46	0	0	0
47	0	0	0
48	0	1	0
49	0	1	0
50	0	3	0
51	0	0	0
52	0	0	0
53	2	0	0
54	0	0	0
55	0	0	0
56	2	0	1
57	0	0	1
58	2	0	0
59	2	0	2
60	3	0	4
61	3	0	2
62	2	0	7
63	4	0	7
64	5	0	16
65	3	0	5
66	4	0	8
67	2	0	15
68	2	0	20
69	4	0	19
70	7	0	13
71	2	0	12
72	3	0	9
73	7	0	8

Table 15 (con't)

Length (cm.)	Males	Jacks	Females
74	0	0	9
75	1	0	4
76	1	0	5
77	0	0	3
78	2	0	4
79	0	0	1
80	0	0	2
81	0	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	1	0	0

Total: 64 24 177

Adipose clips: 1 7 36

Mark rate (%): 1.6 29.2 20.3

¹Summary of random sample of chinook broodstock collected by Cowichan hatchery.

Table 16. Water temperature and depth at the enumeration fence site, 1992

Date	Depth (cm.)	Temp. (deg.C)	Date	Depth (cm.)	Temp. (deg.C)
Aug. 18	200	22	Oct. 25	219	15
19	208	21	26	218	16
20	203	19	27	221	14
21	137	20	28	306	14
22	198	19	29	308	13
23	193	20	30	351	16
24	191	20	01	321	20
25	210	18	02	357	17
26	201	20	03	313	15
27	200	20	04	356	15
28	195	19	05	346	14
29	200	19	06	300	13
30	194	19	07	239	13
31	210	19	08	268	14
Sept. 01	210	19	09	246	13
02	249	18	10	247	13
03	249	18	11	250	14
04	208	18	12	249	17
05	191	18	13	249	12
06	231	15	14	237	11
07	200	15	15	226	8
08	210	17	16	231	10
09	208	17	17	242	11
10	72	17	18	263	12
11	217	16	19	289	11
12	220	17	20	262	12
13	200	16	21	352	12
14	201	15	22	391	11
15	201	14	23	493	12
16	203	13	24	532	11
17	202	14	25	522	12
18	210	14	26	524	11
19	208	15	27	565	11
20	209	17	28	557	12
21	214	17	29	558	12
22	213	17	30	555	11
23	220	17	31	560	12
24	226	16			

Table 17. Daily discharge¹ in cu.m/sec for 1992.

Day	May	Jun	Jul	Aug	Sep	Oct	Nov
1	27.9	5.2	7.3	4.7	6.6	13.4	43.1
2	25.4	5.1	7.4	4.6	6.5	13.4	45.2
3	25.0	4.8	7.1	4.6	6.6	13.6	43.4
4	24.8	5.3	7.2	5.2	6.5	12.8	48.4
5	23.1	5.3	7.4	4.1	7.2	11.6	48.4
6	22.2	5.2	7.5	4.2	5.4	8.0	47.2
7	21.1	5.1	7.1	4.0	5.3	4.6	57.4
8	20.3	5.1	6.9	4.2	5.8	4.7	55.6
9	19.2	5.1	6.9	4.4	5.6	5.0	53.4
10	18.7	5.3	7.2	4.6	5.6	4.9	51.1
11	16.5	5.1	7.5	4.9	5.8	5.0	53.3
12	13.2	5.2	7.4	4.6	6.0	5.0	51.7
13	12.6	5.5	7.2	5.1	5.7	5.1	49.3
14	11.8	5.7	7.0	5.2	5.5	4.9	48.0
15	11.2	6.4	7.1	5.1	5.3	4.9	16.2
16	10.5	6.5	7.0	5.1	5.4	5.0	44.5
17	9.8	6.5	6.9	5.2	5.4	4.9	42.7
18	9.6	6.6	6.0	5.5	5.6	6.1	41.9
19	9.2	6.6	5.2	5.3	5.6	7.1	48.3
20	8.9	6.7	5.2	5.2	5.6	7.9	47.3
21	8.5	6.8	5.5	5.2	5.5	10.8	62.1
22	8.1	6.5	5.5	5.2	5.3	14.9	72.6
23	8.2	6.4	5.2	5.0	5.6	22.8	63.2
24	8.0	6.5	5.1	5.8	5.8	26.6	57.9
25	8.0	6.3	4.9	5.8	5.5	25.7	54.5
26	8.1	6.4	4.8	5.8	5.6	27.2	52.0
27	8.5	6.2	5.0	5.6	7.9	29.4	59.4
28	8.7	7.0	5.0	5.5	11.3	29.0	64.6
29	6.0	7.3	5.0	5.7	13.1	28.4	61.8
30	5.6	7.3	4.7	6.3	13.2	28.9	65.7
31	5.1		4.6	6.6		34.8	
Total:	424.4	179.3	194.9	159.8	192.6	440.5	1580.3
Mean:	13.7	5.9	6.3	5.1	6.4	14.2	52.7

¹Water Survey of Canada data recorded at the Island Highway bridge in Duncan. Since the metre at this site malfunctioned from Sept. 6 to Oct. 6, the discharge data from the Lake Cowichan gauge was used for this time period.

Table 18. Summary of chinook tagged at the enumeration fence, 1992.

Date (dd/mm)	Male		Female		Jacks	
	Tagged ¹	Untagged	Tagged	Untagged	Tagged	Untagged
21/08	0	0	0	0	1	0
22/08	0	0	1	0	0	1
23/08	0	0	0	0	1	0
24/08	0	0	1	0	1	0
25/08	0	0	0	0	6	1
26/08	1	0	0	0	0	0
27/08	0	0	0	0	3	0
28/08	1	0	0	0	6	0
29/08	1	0	2	0	4	0
30/08	1	0	2	0	2	0
31/08	0	0	2	0	1	0
01/09	10	0	5	0	5	2
02/09	3	0	4	0	0	5
03/09	3	0	2	0	0	5
04/09	1	0	3	0	7	0
05/09	4	0	1	0	3	0
06/09	1	0	2	0	1	3
07/09	2	0	1	0	1	0
08/09	3	0	2	0	3	1
09/09	3	0	1	0	3	0
10/09	0	0	0	0	1	0
11/09	3	0	1	0	4	0
13/09	0	0	3	0	2	0
14/09	0	0	1	0	5	0
15/09	4	0	3	0	7	0
16/09	1	0	1	0	7	0
17/09	1	0	2	0	8	0
18/09	0	0	0	0	8	0
19/09	2	0	0	0	6	1
20/09	2	0	0	0	10	0
21/09	3	0	4	0	18	0
22/09	12	0	18	0	11	1
23/09	13	0	30	0	6	0
24/09	20	0	38	0	52	2
25/09	8	0	13	0	10	0
26/09	8	0	11	0	12	0
27/09	5	0	9	0	7	0
28/09	20	7	28	8	15	14
29/09	27	6	29	6	15	21
30/09	10	0	7	1	18	1
01/10	15	1	21	2	10	4
02/10	14	2	28	1	14	0
03/10	21	2	29	2	20	1
04/10	6	0	16	1	4	1
05/10	8	28	9	20	9	4

Table 18 (con't.)

Date (dd/mm)	Male		Female		Jacks	
	Tagged ¹	Untagged	Tagged	Untagged	Tagged	Untagged
06/10	2	0	2	3	4	0
07/10	0	0	0	3	0	0
08/10	0	1	1	1	6	0
09/10	6	0	7	1	0	1
10/10	6	0	12	0	2	0
11/10	21	18	37	27	28	11
12/10	9	0	18	1	10	0
13/10	13	0	21	2	5	0
14/10	1	1	7	1	5	0
15/10	5	0	5	0	7	0
16/10	12	0	12	2	13	1
17/10	22	3	26	3	22	0
18/10	35	39	33	15	8	48
19/10	24	0	23	0	25	0
20/10	52	0	86	0	19	0
21/10	16	0	33	0	3	0
22/10	34	2	52	1	0	9
23/10	8	0	13	0	0	0
24/10	10	0	16	0	0	0
25/10	4	0	2	0	0	0
26/10	3	0	2	0	0	0
27/10	11	0	9	0	0	0
30/10	3	0	2	0	0	0
Total:	534	110	749	101	484	138

Table 18 (con't.)

Date (dd/mm)	Male		Female		Jacks	
	Clip ²	Noclip	Clip	Noclip	Clip	Noclip
21/08	0	0	0	0	0	1
22/08	0	0	0	1	0	1
23/08	0	0	0	0	0	1
24/08	0	0	0	1	0	1
25/08	0	0	0	0	0	7
26/08	0	1	0	0	0	0
27/08	0	0	0	0	0	3
28/08	0	1	0	0	0	6
29/08	0	1	0	2	0	4
30/08	0	1	1	1	0	2
31/08	0	0	0	2	0	1
01/09	1	9	0	5	0	7
02/09	0	3	1	3	0	5
03/09	1	2	0	2	0	5
04/09	0	1	0	3	0	7
05/09	0	4	0	1	0	3
06/09	0	1	0	2	0	4
07/09	0	2	0	1	0	1
08/09	0	3	1	1	0	4
09/09	0	3	0	1	0	3
10/09	0	0	0	0	0	1
11/09	0	3	0	1	0	4
13/09	0	0	0	3	0	2
14/09	0	0	0	1	0	5
15/09	0	4	0	3	0	7
16/09	0	1	0	1	0	7
17/09	0	1	0	2	0	8
18/09	0	0	0	0	0	8
19/09	1	1	0	0	0	7
20/09	0	2	0	0	0	10
21/09	1	2	1	3	0	18
22/09	0	12	0	18	0	12
23/09	1	12	3	27	0	6
24/09	3	17	2	36	0	54
25/09	0	8	2	11	1	9
26/09	1	7	2	9	1	11
27/09	0	5	0	9	0	7
28/09	2	25	1	35	0	29
29/09	4	29	0	35	2	34
30/09	2	8	2	6	1	18
01/10	3	13	1	22	0	14
02/10	0	16	0	29	3	11
03/10	2	21	2	29	1	20
04/10	1	5	0	17	0	5
05/10	3	33	1	28	0	13
06/10	1	1	0	5	1	3
07/10	0	0	0	3	0	0

Table 18 (con't.)

Date (dd/mm)	Male		Female		Jacks	
	Clip ²	Noclip	Clip	Noclip	Clip	Noclip
08/10	0	1	0	2	0	6
09/10	0	6	1	7	0	1
10/10	1	5	2	10	0	2
11/10	3	36	6	58	3	36
12/10	2	7	3	16	1	9
13/10	3	10	1	22	0	5
14/10	0	2	0	8	0	5
15/10	0	5	0	5	0	7
16/10	1	11	1	13	1	13
17/10	3	22	2	27	3	19
18/10	1	73	1	47	0	56
19/10	1	23	1	22	1	24
20/10	1	51	1	85	0	19
21/10	3	13	0	33	0	3
22/10	3	33	3	50	0	9
23/10	1	7	0	13	0	0
24/10	2	8	2	14	0	0
25/10	1	3	0	2	0	0
26/10	0	3	0	2	0	0
27/10	4	7	0	9	0	0
30/10	0	3	0	2	0	0
Total:	57	587	44	806	19	603

¹Chinook tagged with Ketchum aluminum sheep ear tag

²Adipose fin clipped chinook

Table 19. Summary of chinook sampled on the spawning grounds, 1992

Date (dd/mm)	Male		Female		Jacks	
	Tagged ¹	Untagged	Tagged	Untagged	Tagged	Untagged
26/10	1	2	1	4	0	0
29/10	0	1	1	2	0	1
30/10	1	7	3	15	0	4
02/11	2	7	5	26	0	5
03/11	4	16	7	33	3	13
04/11	1	21	10	66	0	15
05/11	1	10	0	9	0	4
06/11	0	22	7	68	0	10
09/11	0	15	3	62	0	13
10/11	0	19	6	52	0	24
11/11	0	5	0	14	0	4
12/11	3	30	5	75	0	37
13/11	0	10	2	11	0	6
16/11	0	25	5	59	1	36
17/11	0	20	4	39	0	33
18/11	1	11	4	38	2	31
19/11	0	1	0	3	0	2
20/11	1	13	3	36	1	22
23/11	0	5	0	17	0	8
24/11	0	5	1	6	0	6
26/11	0	5	0	14	0	7
27/11	0	3	0	7	0	1
Total:	15	253	67	656	7	282

Table 19 (con't)

Date (dd/mm)	Male		Female		Jacks	
	Clip ²	Noclip	Clip	Noclip	Clip	Noclip
26/10	1	2	2	3	0	0
29/10	0	1	0	3	0	1
30/10	0	8	1	17	0	4
02/11	1	8	1	30	2	3
03/11	2	18	2	38	3	13
04/11	1	21	2	74	1	14
05/11	1	10	3	6	0	4
06/11	3	19	7	68	0	10
09/11	4	11	0	65	1	12
10/11	2	17	6	52	0	24
11/11	0	5	2	12	0	4
12/11	7	26	9	71	7	30
13/11	0	10	1	12	0	6
16/11	3	22	6	58	3	34
17/11	1	19	1	42	1	32
18/11	1	11	1	41	4	28
19/11	0	1	0	3	0	2
20/11	1	13	2	37	4	19
23/11	0	5	0	17	1	7
24/11	0	5	0	7	0	6
26/11	0	5	1	13	0	7
27/11	0	3	0	7	0	1
Total:	28	240	47	676	27	261

¹chinook tagged with Ketchum aluminum sheep ear tag

²adipose fin clipped chinook

Table 20. Simple Petersen chinook escapement estimates by sex, Cowichan River, 1992.

Sex	Escapement estimate	95% Confidence limit	
		Lower	Upper
Male ¹	8,994	6,814	11,174
Female	7,985	7,064	8,906
Total	15,346	13,734	16,958

¹ Adult males only, jacks not included

Table 21. Recoveries from chinook tagged in successive weeks at the fence, divided according to week of recovery upstream:

	Week of Tagging (i)											Tagged fish Recovered (R _j)	Total fish Recovered (C _j)	C _j / R _j		
	1	2	3	4	5	6	7	8	9	10	11					
Week of Recovery (j):																
1	-	-	-	-	-	1	-	-	2	2	-	5(7) ¹	38	7.6(5.4) ¹		
2	-	1	-	-	-	3	5	1	4	14	-	28(40)	315	11.2(7.9)		
3	-	-	-	-	-	4	3	1	2	5	-	15(19)	312	20.8(16.4)		
4	-	-	1	-	-	1	1	2	2	8	-	15(22)	263	17.5(11.9)		
5	-	-	-	-	-	-	-	-	-	1	-	1	63	63.0		
Tagged fish recovered (R _i)	-	1	1	-	-	9	9	4	10	30	-					
Total fish tagged (M _i)	1	6	41	19	18	180	263	75	209	435	36					
M _i / R _i	-	6.0	41.0	-	-	20.0	29.2	18.7	20.9	14.5	-					

Computed estimates of chinook escapement using Schaeffer's method:

	Week of Tagging (i)									
	1	2	3	4	5	6	7	8	9	10
Week of Recovery (j):										
1	-	-	-	-	-	152(108) ¹	-	-	159(113)	110(78)
2	-	67(47)	-	-	-	224(158)	327(231)	209(148)	234(165)	162(115)
3	-	-	-	-	-	416(328)	607(479)	389(307)	435(343)	302(238)
4	-	-	717(488)	-	-	350(238)	511(347)	327(223)	365(249)	254(172)
5	-	-	-	-	-	-	-	-	-	913(913)
Estimated escapement per period i		67 (47)	717 (488)			1142 (832)	1445 (1057)	925 (678)	1193 (870)	1741 (1516)

Total escapement estimate: 7,230(5,488)
 Upper 95% confidence limit: 10,798(9,076)
 Lower 95% confidence limit: 4,305(2,583)

¹total number of tagged fish recovered (in parenthesis) includes secondary tagged fish as well as those fish that had lost the tag but had an obvious notch where the tag used to be.

Table 22. Incidence of tagged chinook recovered on the spawning grounds, by period, in the Cowichan R., 1992

Recovery Period	Recovered with tag ¹		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 26-31	7	7.9	43	3.3	16.3
Nov. 1-7	40	44.9	365	28.5	10.9
Nov. 8-14	19	21.3	396	30.9	4.8
Nov. 15-21	22	24.7	391	30.5	5.6
Nov. 22-28	1	1.1	85	6.6	1.2
Total:	89	-	1280	-	6.9

¹includes fish which had lost the tag but had an obvious notch in the operculum where tag used to be.

Table 23. Proportion of the tag application sample recovered¹ on the spawning grounds, by period, on the Cowichan R., 1992

Application period	Tags applied	Tags recovered ²	Recoveries (%)
Aug. 16-22	1	-	-
Aug. 23-29	6	1	16.7
Aug.30-Sept.5	41	1	2.4
Sept. 6-12	19	0	-
Sept. 13-19	18	0	-
Sept. 20-26	180	9	5.0
Sept.27-Oct.3	263	9	3.4
Oct. 4-10	75	4	5.3
Oct. 11-17	209	10	4.8
Oct. 18-24	435	30	6.9
Oct. 25-31	36	-	-
Total:	1283	64	4.9

¹Tag recovery sampling did not begin until Oct. 26

²includes only those fish recovered with tag intact

Table 24. Incidence of marks by section of the Cowichan R., 1992

Section ¹	Carcasses examined		Tagged carcasses recovered ²		Mark incidence (%)
	No.	%	No.	%	
Upper	741	60	56	64	7.5
Lower	482	40	32	36	6.6
Total:	1223		88		7.2

¹Upper refers to the part of the river between Birdhouse and Three firs pool (section 1 to 6). Lower refers to the part of the river just below Marie Canyon to the enumeration fence (section 7 to 12).

²includes fish which had lost tag but had an obvious notch in the operculum where tag used to be.

Table 25. Incidence of tagged chinook recovered¹ on the spawning grounds, by section of river and by period, in the Cowichan R., 1992

Upper River ²					
Recovery Period	Recovered with tag		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 26-31	7	12.5	43	5.8	16.3
Nov. 1-7	27	48.2	159	21.4	16.9
Nov. 8-14	12	21.4	221	29.8	5.4
Nov. 15-21	9	16.1	249	33.6	3.6
Nov. 22-28	1	1.8	69	9.3	1.4
Total:	56	-	741	-	7.5

Lower River ³					
Recovery Period	Recovered with tag		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 26-31	-	-	-	-	-
Nov. 1-7	12	37.5	175	36.3	6.8
Nov. 8-14	7	21.9	157	32.6	4.4
Nov. 15-21	13	40.6	134	27.8	9.7
Nov. 22-28	-	-	16	3.3	-
Total:	32	-	482	-	6.6

¹includes fish which had lost the tag but had an obvious notch in the operculum.

²Refers to the part of river between Birdhouse and Three Firs pool (section 1 to 6)

³Refers to the part of the river just below Marie Canyon and the enumeration fence (section 7 to 12)

Table 26. Sex composition of application and recovery samples of tagged chinook, Cowichan R., 1992

Sex		Application sample			Recovery sample		
		Recovered	Not Recovered	Total	Marked	Unmarked	Total
Male	Percent	17	31	31	17	21	21
	No.	15	519	534	15	253	268
Jacks	Percent	8	29	27	8	24	23
	No.	7	477	484	7	282	289
Female	Percent	75	40	42	75	55	56
	No.	67	682	749	67	656	723
Total:	No.	89	1678	1767	89	1191	1280

¹includes fish which had lost the operculum tag but had an obvious notch in the operculum, or had an operculum punch as a secondary tag.

Table 27. Total adult chinook returns to the Cowichan R., 1975-1992.

Year	Natural spawner	Brood stock	Native catch	Total return
1975	6500		900	7400
1976	3460		1000	4460
1977	4150		1000	5150
1978	4370		500	4870
1979	8750	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 ^a	535 ^b	1055	2586
1990	4164	326	604	5094
1991	4086 ^c	1755	270	5065
1992	6676	1850	260	8678

^aNumbers of adults recorded at the fence minus the adults removed for broodstock above the fence

^bTotal broodstock removed

^cIncludes 2000 adult chinook estimated to have passed by the fence during the period of high water

Fig. 1 Cowichan River Survey Areas:**Swim survey areas:**

- 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

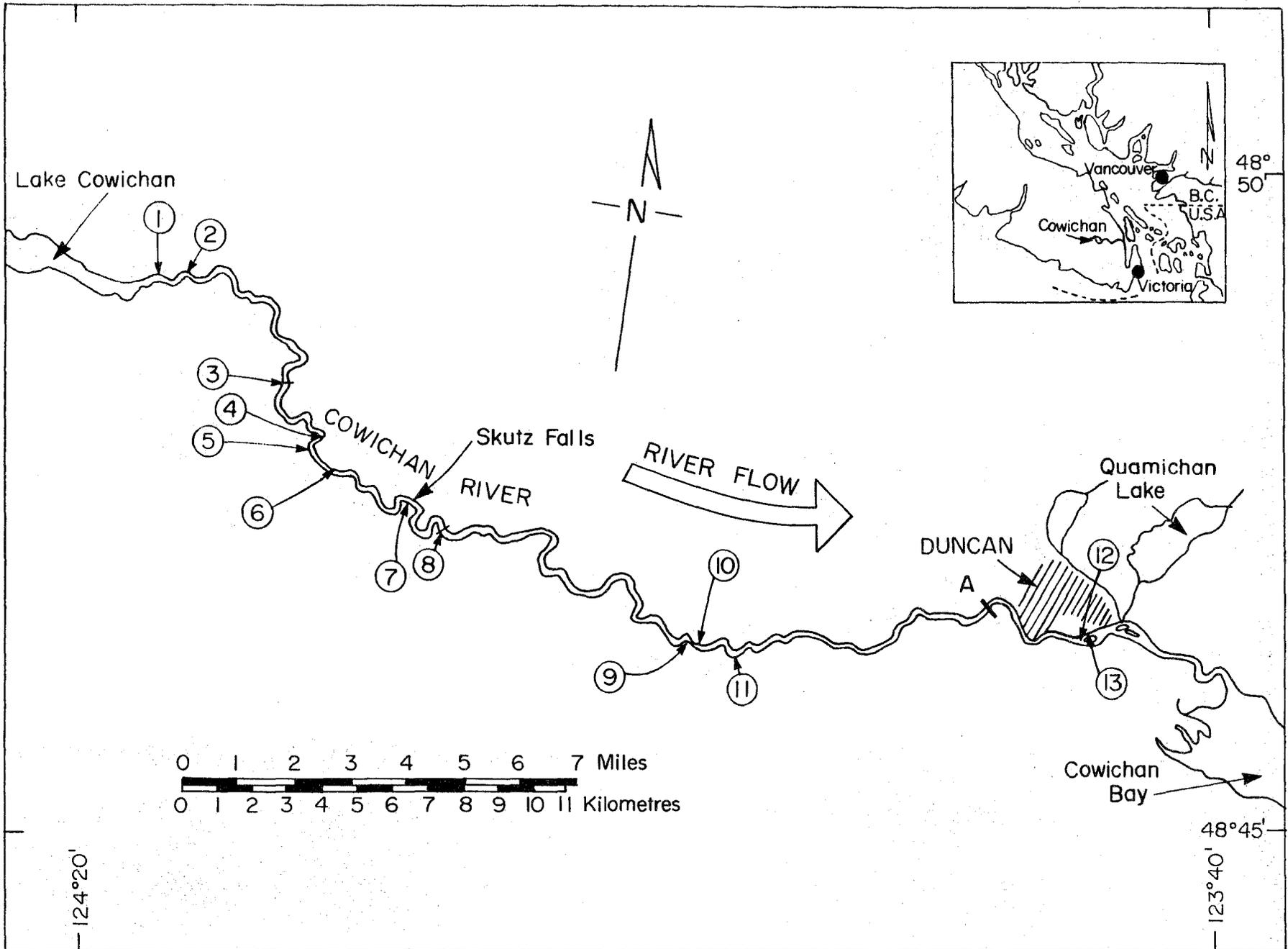
Carcass recovery survey areas:

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.

Note: A-Adult enumeration fence

Note: Section of river that changed course in 1991 was between the Train Trestle (3) and the Old pickup site (4).



**Fig. 2 River Management Zones:
(Native food fishery)**

A-Cliffs to Silver bridge

B-Silver bridge to JC pool

C-Quamichan to Black creek

D-Powerline to Elliot's barn

E-Elliot's barn to Brian's pool

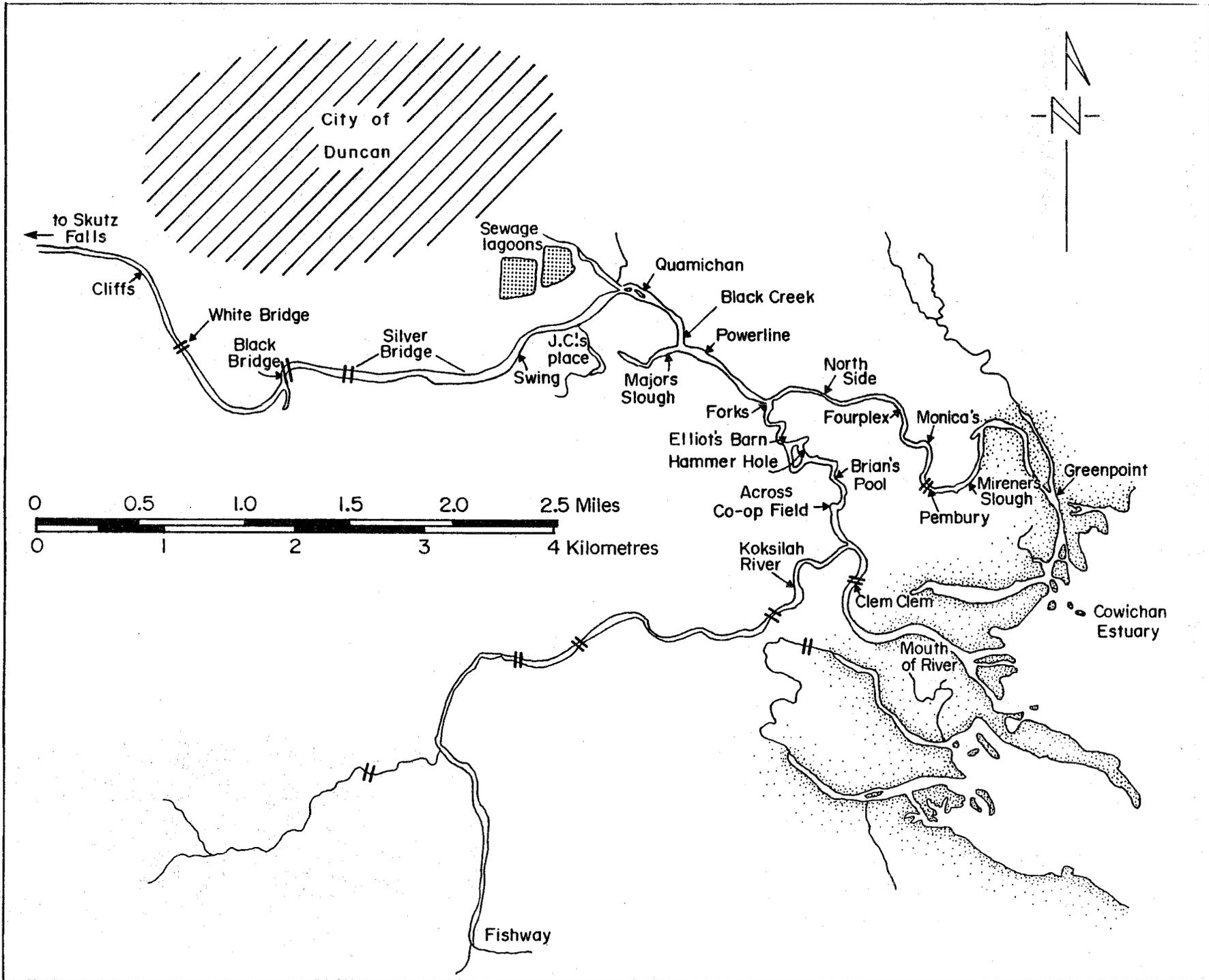
F-Brian's pool to Clem Clem and
part of Koksilah

G-below Clem Clem to mouth

H-North fork to Fourplex Rd.

I-below Fourplex to Meriner's
pool

J-Meriner's pool to mouth



Cowichan River, 1992

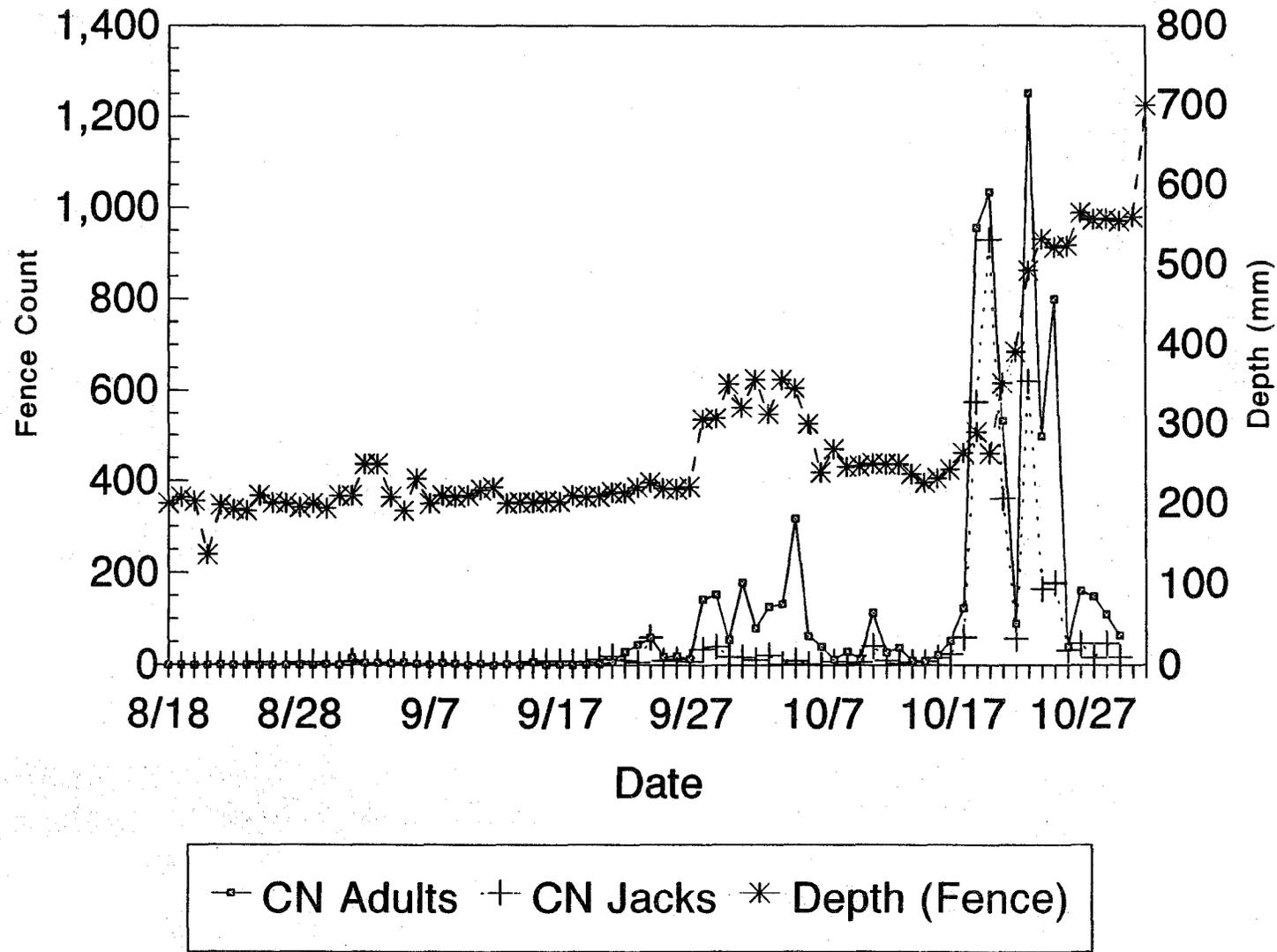
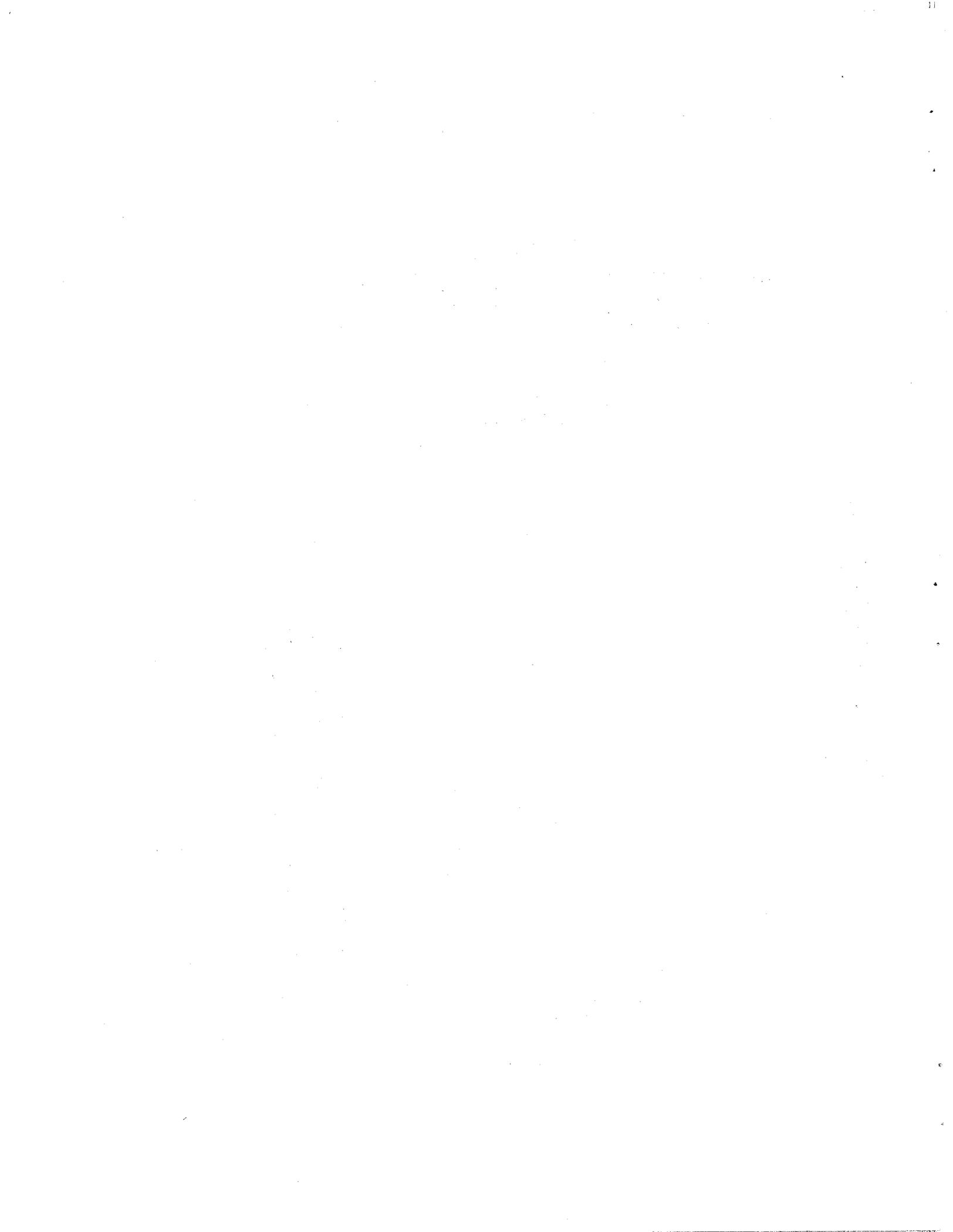
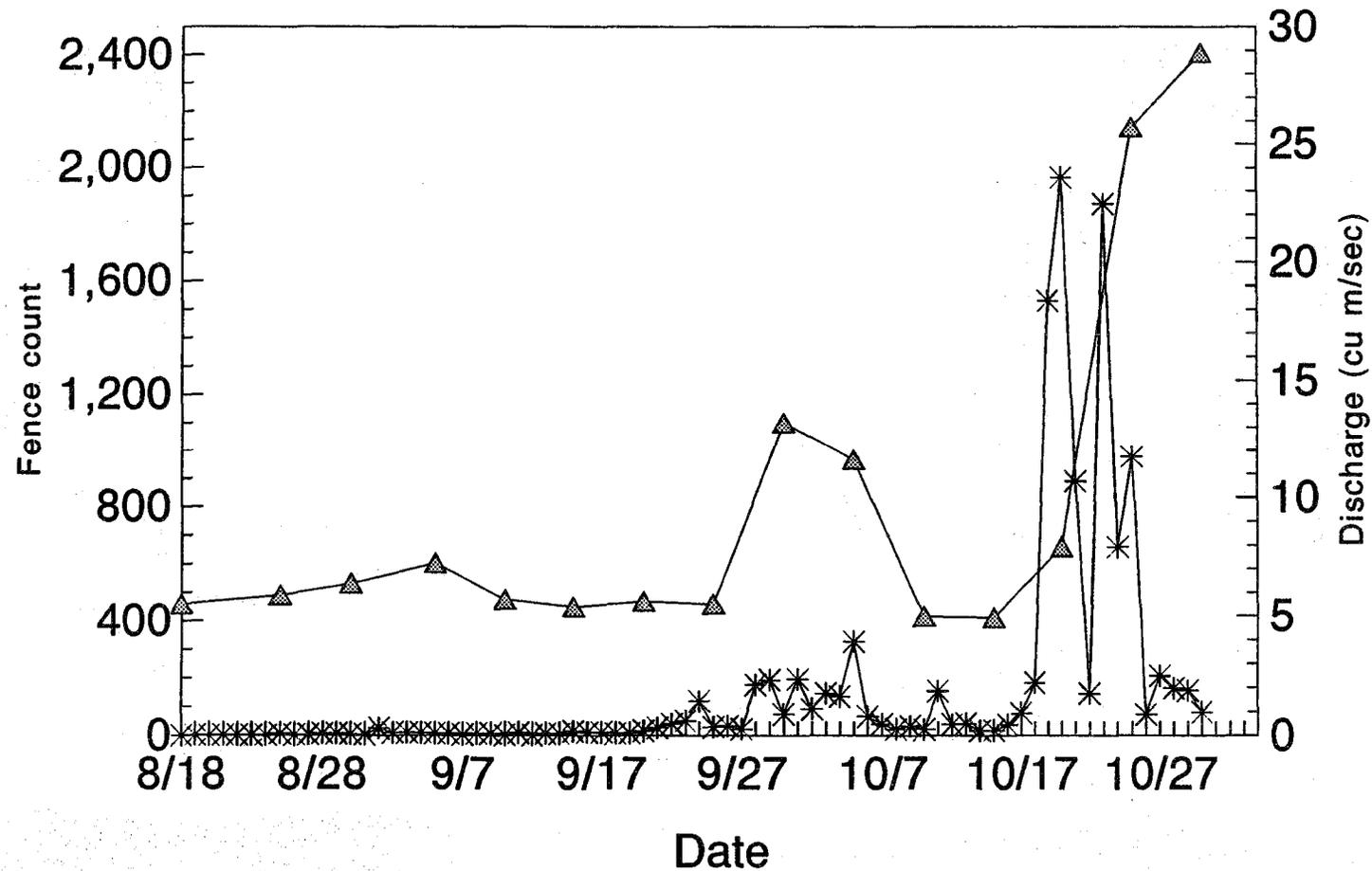


Fig. 3 Daily fence count of chinook.



Cowichan River, 1992



* Total Chinook ▲ Flow (cu m/sec)

Fig. 4. Discharge at the Island Highway bridge in Duncan (Water Survey of Canada) and fence count.

Cowichan River, 1992

Fence Count vs Swim Survey

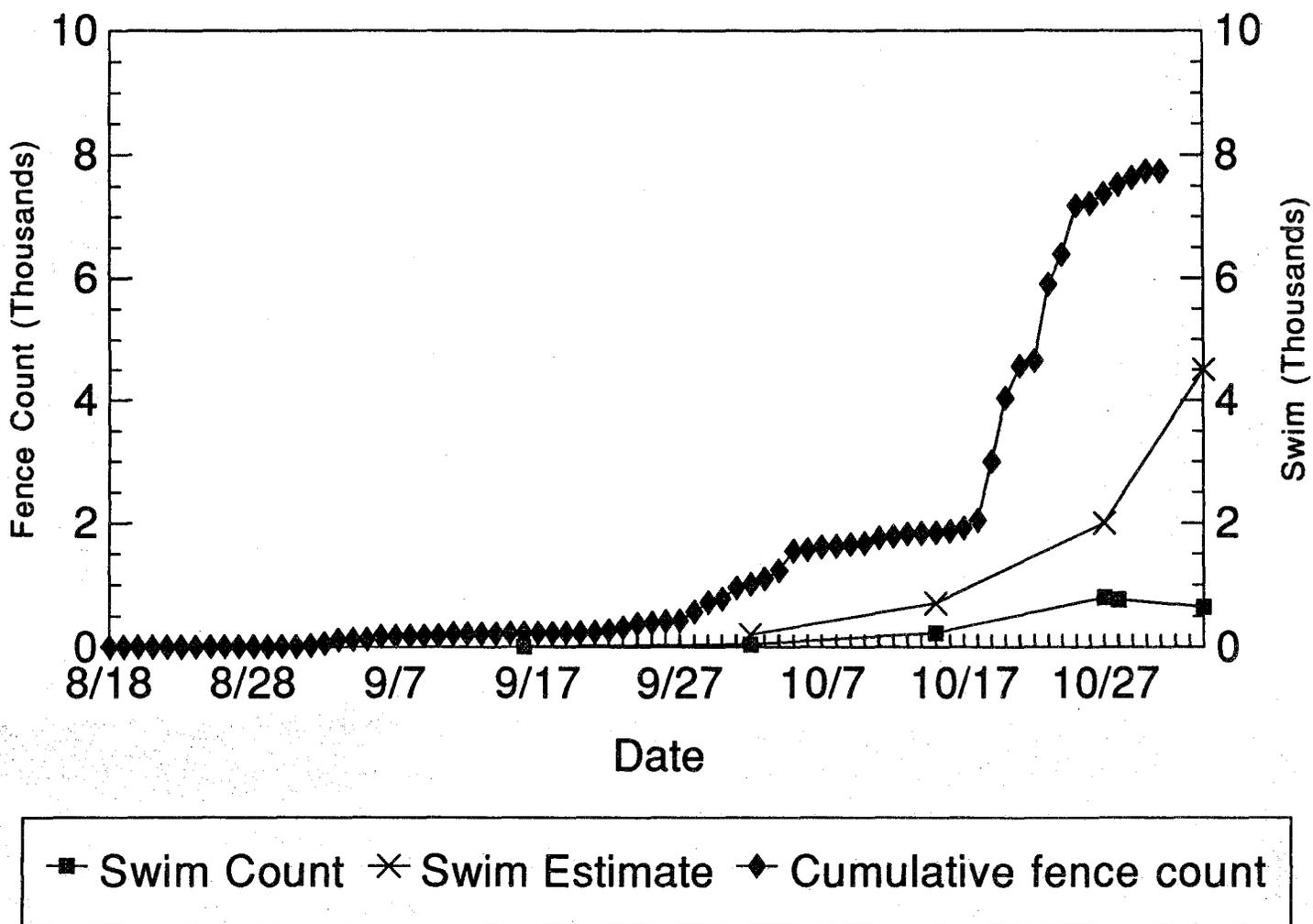


Fig. 5. Fence count compared with swim survey data.

Appendix Table 1. Swim survey comparison data, Cowichan R., 1992
 A. Different swim teams, same day:

Swim Survey					
Swimmers: J. Candy, T. Fields, D. Nagtegaal (canoe)					
Weather: sunny					
Water clarity: good					
Date: Oct. 15					
Start time: 10 AM					
Pool name		CN Adults	CN Jacks	Coho	Chum
Road Pool		5	8		
Sewer Line			5		
Shute		64	62		
Gravel Bank		68	44		
Trestle		97	120		
Ginter's		32	70		
Three Firs		25	50		
Total:		291	359		

Swim Survey					
Swimmers: R. Hanelt, G. Williams, D. August (canoe)					
Weather: sunny					
Water clarity: good					
Date: Oct. 15					
Start time: 11 AM					
Pool name		CN Adults	CN Jacks	Coho	Chum
Road Pool		4	0		
Sewer Line			0		
Shute		28	19		
Gravel Bank		51	9		
Trestle		60	57		
Ginter's		3	11		
Three Firs		16	17		
Total:		162	113		

Appendix Table 1 (con't)
 B. Same swim team, different days:

Swim Survey						
Swimmers: J. Candy, R. Hanelt, Ricardo, D. Hardie, D. Nagtegaal (canoe)						
Weather: sunny						
Water clarity: good						
Date: Oct. 27						
Start time: 10:00 AM						
Pool name		CN Adults	CN Jacks	CN carcasses	Coho	Chum
Bird House		130	70			
Road Pool		165	130			
Sewer line		238	166			
Shute		50	30			
Gravel Bank		90	50			
Trestle		24	15			
Ginter's		95	54			
Three firs		5	0			
Total:		797	515			

Swim Survey						
Swimmers: J. Candy, R. Hanelt, Ricardo, D. Hardie, D. Nagtegaal (canoe)						
Weather: cloudy						
Water clarity: good						
Date: Oct. 28						
Start time: 10:00 AM						
Pool name		CN Adults	CN Jacks	CN carcasses	Coho	Chum
Bird House		90	100			
Road Pool		188	145			
Sewer line		182	157			
Shute		46	30			
Gravel Bank		49	43			
Trestle		128	54			
Ginter's		82	62			
Three firs		2	0			
Total:		767	591			

Appendix Table 1 (con't)

C. Different swim teams, same day:

Swim Survey					
Swimmers: G. Williams, Ricardo, J. Betz, A. Johnny (canoe)					
Weather: cloudy, partially sunny					
Water clarity: good					
Date: Nov. 13					
Start time: 10:45 AM					
Pool name	CN Adults	CN Jacks	CN carcasses	Coho	
Bird House	131	65		57	
Road Pool	138	174		39	
Sewer line	126	184		42	
Shute	28	26		24	
Gravel Bank	0	0		0	
Trestle	10	44		236	
Ginter's	34	10		174	
Three firs	0	3		43	
Total:	467	506	0	615	

Swim Survey						
Swimmers: J. Candy, J. August, K. Smith, D. Nagtegaal (canoe)						
Weather: cloudy, partially sunny						
Water clarity: good						
Date: Nov. 13						
Start time: 11:45 AM						
Pool name	CN Adults	CN Jacks	CN carcasses	Coho	Chum	
Bird House	95	95	3			
Road Pool	250	220	6			
Sewer line	110	90	4			
Shute	11	0	6			
Gravel Bank	35	10	0			
Trestle	32	20	2			
Ginter's	68	15	7			
Three firs	14	0	0			
Total:	615	450	28			

Appendix Table 2. Tag code data from chinook sampled on the spawning grounds, 1992

Recovery date	Length (mm)	Sex	BY	Tagcode ¹	Release ³ location	Recovery ² location
261092	600	2	88	2-55-24	late	below fence
261092	690	2	88	2-50-15	early	below fence
301092	630	2	89	2-3-52	early	powerline
021192	370	J	90	2-11-43	Nanaimo	stoltz
021192	580	2		no-pin		
021192	440	J	90	2-3-40	late	stoltz
021192	590	1	89	2-62-55	lake pen	r pool
031192	438	J	90	2-3-34	lake pen	r pool
031192	380	J	90	2-3-39	late	sand bank
031192	310	1	88	2-50-12	late	below fence
031192	685	2	88	2-48-60	early	sand bank
031192	460	1	90	2-3-40	late	vimy
031192	350	J	90	2-3-43	sea pen	vimy
031192	590	2	89	2-61-3	early	below fence
041192	510	1	89	2-62-57	lake pen	r pool
041192	653	1	89	2-62-55	lake pen	sand bank
041192	689	2	88	2-57-52	lake pen	blk 51
041192	752	2	89	2-62-57	lake pen	r pool
051192	630	2	89	2-6-24	late	vimy
051192	650	2		no-pin		
051192	790	2	88	2-50-15	early	below fence
051192	660	1	89	2-9-39	early	below fence
061192	570	1	89	2-3-52	early	stoltz
061192	750	2		no-pin		
061192	658	2	89	2-6-63	Qualicum	r pool
061192	593	2	89	2-62-56	lake pen	blk 51
061192	730	2	88	2-50-16	early	stoltz
061192	560	2	88	2-50-16	early	powerline
061192	700	1	88	2-55-23	late	stoltz
061192	590	2	89	2-6-22	late	stoltz
061192	730	1	88	2-57-49	lake pen	powerline
061192	561	2		no-pin		
091192	550	1	89	2-6-24	late	stoltz
091192	620	1	89	2-6-22	late	stoltz
091192	590	1	89	2-6-24	late	stoltz
091192	560	1	89	2-5-22	late	stoltz
101192	590	2	89	2-62-56	lake pen	r pool
101192	660	2	88	2-48-60	early	r pool
101192	650	2	88	2-54-57	Saanich	r pool
101192	580	2	89	2-6-23	late	r pool
101192	560	1	89	2-62-56	lake pen	r pool
101192	480	1	90	2-3-40	late	r pool
101192	660	2	89	2-6-24	late	r pool
101192	600	2	89	2-6-23	late	r pool
111192	650	2	88	2-50-16	early	vimy
111192	680	2	88	2-55-24	late	vimy
121192	578	1	89	2-6-24	late	r pool

Appendix Table 2 (cont.)

Recovery date	Length (mm)	Sex	BY	Tagcode	Release location	Recovery location
121192	610	2	89	2-6-24	late	r pool
121192	335	J		no-pin		
121192	368	J		no-pin		
121192	615	2	89	2-6-24	late	r pool
121192	619	2		no-pin		
121192	437	J	90	2-3-41	late	r pool
121192	638	2	89	2-62-58	lake pen	r pool
121192	453	J	90	2-3-37	early	r pool
121192	539	1	89	2-6-22	late	r pool
121192	570	2	88	2-48-60	early	stoltz
121192	410	J	90	2-3-40	late	r pool
121192	750	2	88	2-54-57	Saanich	stoltz
121192	330	J	90	2-3-40	late	stoltz
121192	655	2		no-pin		
121192	562	2		no-pin		
121192	542	1	89	2-6-24	late	r pool
121192	575	1	89	2-6-23	late	r pool
121192	480	1	89	2-6-24	late	stoltz
121192	655	2		no-pin		
121192	540	1	89	2-5-22	late	stoltz
131192	740	2		lost-pin		
161192	780	2	88	2-50-15	early	stoltz
161192	466	1	90	2-3-39	late	r pool
161192	575	2	89	2-6-22	late	r pool
161192	363	J	90	2-3-37	early	r pool
161192	620	2	89	2-5-22	late	stoltz
161192	690	2	88	2-50-16	early	stoltz
161192	600	2	89	2-6-22	late	stoltz
161192	504	1	90	2-3-33	lake pen	r pool
161192	446	1	90	2-3-37	early	r pool
161192	410	J	90	2-3-39	late	stoltz
161192	770	2	88	2-57-54	Saanich	stoltz
161192	425	J	90	2-3-37	early	r pool
171192	650	2	89	2-6-22	late	vimy
171192	395	J	90	2-3-41	late	sand bank
171192	573	1		no-pin		
181192	461	J	90	2-3-37	early	sand bank
181192	320	J		no-pin		
181192	398	J	90	2-3-34	lake pen	r pool
181192	326	J		no-pin		
181192	660	2	88	2-50-16	early	powerline
181192	580	1	89	2-6-23	late	stoltz
201192	370	J	90	2-3-39	late	sand bank
201192	376	J	90	2-3-41	late	sand bank
201192	630	2	89	2-6-23	late	stoltz
201192	342	J	90	2-3-42	sea pen	sand bank
201192	381	J	90	2-3-39	late	sand bank

Appendix Table 2 (cont.)

Recovery date	Length (mm)	Sex	BY	Tagcode	Release location	Recovery location
201192	610	2	89	2-6-22	late	stoltz
201192	550	1	88	2-50-16	early	stoltz
231192	410	J	90	2-3-41	late	vimy
261192	599	2	89	2-6-23	late	r pool

¹no-pin refers to no pin found; lost pin refers to a pin that was lost in the processing procedure.

²Recovery locations (refer to Fig. 1):

R pool; Road pool

BLK 51; Block 51

³Release locations:

Early; early hatchery release (during April)

Late; late hatchery release (during May)

Lake pen; hatchery fish released from pens in Lake Cowichan (during May)

Sea pen; hatchery fish released from pens in Cowichan estuary (during June)

Nanaimo; Nanaimo R. Hatchery

Qualicum; Big Qualicum Hatchery

Saanich; Cowichan R. stock transferred to seapen site in Saanich Inlet.

Appendix Table 3. Tag code data for chinook sampling from the Indian food fishery, 1992

Recovery date	Length (mm)	Sex	BY	Tagcode ¹	Release ³ location	Recovery ² location
020992	710	F		no data		
030992	690	F	89	2-62-56	lake pen	Zone H
030992	650	M	89	2-5-22	late	Zone H
030992	660	F	88	2-55-24	late	Zone H
050992	440	J	90	2-3-37	early	Zone H
050992	490	J		no-pin		Zone H
130992	595	M	89	2-3-52	early	Zone D
190992	435	J		no data		
190992	654	F	89	2-62-58	lake pen	Zone H
190992	669	F	88	2-50-17	early	Zone H
200992	830	F		no data		
230992	680	F		no-pin		Zone C
230992	450	J		no-pin		Zone C
240992	630	F	89	2-6-23	late	Zone C
250992	610	F		no data		
111092	567	F		no data		
141092	747	M		no data		
141092	700	F	89	2-62-61	Saanich	Zone D
141092	430	J	90	2-3-41	late	Zone D
151092	740	F		no data		
211092	700	M		no-pin		Zone D
211092	766	M	88	2-57-52	lake pen	Zone D
221092	780	M		no-pin		Zone H
231092	668	F		no data		
041192	669	M	90	2-3-36	early	Zone H
041192	639	M		no data		

¹no-pin refers to no pin found; no data refers to head recovered with no associated recovery data

²Recovery locations (refer to Fig.2):

³Release locations:

Early; Early hatchery release (during April)

Late; Late hatchery release (during May)

Lake pen; Hatchery fish released from pens in Lake Cowichan (during May)

Saanich; Cowichan hatchery stock transferred to seapens in Saanich Inlet.