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ABUNDANCE, AGE, SIZE, SEX AND CODED WIRE TAG RECOVERIES FOR CHINOOK SALMON ESCAPEMENTS OF CAMPBELL AND QUINSAM RIVERS, 1989-1990

by

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ABSTRACT

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Estimates of escapement were derived for the Campbell/Quinsam rivers system for 1989-90 using carcass tagging as part of the chinook key stream program. The Petersen carcass tagging estimate of chinook escapement was 14825 in 1989 and 15538 in 1990. Both males and females were predominantly age 4 and 5 but the specific age structure varied between years and between the Campbell River, Quinsam River and Quinsam Hatchery. Escapement estimates are presented by river, sex, and age.

Escapement of adipose clipped chinook to the entire system was 1112 in 1989 and 612 in 1990. These estimates were further stratified by age, sex and tag code. The total hatchery contribution (marked and unmarked) to the escapement was estimated by expanding the number of observed adipose clips by the adipose clip mark rate at release. In 1989 the hatchery contribution was 87.1% and 100.0% for male and female chinook escapements, respectively. The hatchery contribution decreased in 1990 to 53.0% for males and 62.2% for females. These hatchery contribution estimates were compared with those estimated using the Mark Recovery Program (Kuhn 1988) method of coded wire tag expansions. Using the MRP method, the total hatchery contribution was 78.9% for males and 80.3% for females in 1989. The hatchery contribution in 1990 was estimated at 49.4% for males and 56.4% for females.

Key words: Campbell, Quinsam, chinook, key stream, escapement, coded wire tags, live tagging, carcass tagging

RÉSUMÉ

Bocking, R.C. 1991. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1989-1990. Can. Manuscr. Rep. Fish. Aquat. Sci. 2124 : x + 109 p.

On a obtenu des estimations de l'échappée en 1989-1990 dans les bassins des rivières Campbell et Quinsam à partir de données d'étiquetage de carcasses de saumon quinnat recueillies dans le cadre du programme sur les cours d'eau clés. Selon l'estimation de Petersen, l'échappée se situait à 14 825 saumons quinnats en 1989 et 15 538 saumons quinnats en 1990. Autant les mâles que les femelles étaient en majorité âgés de quatre et de cinq ans, mais la structure des âges variait d'une année à l'autre et entre la rivière Campbell, la rivière Quinsam et la pisciculture de Quinsam. Les estimations de l'échappée sont ventilées selon la rivière, le sexe et l'âge.

En 1989 et 1990, l'échappée de saumons quinnats dont la nageoire adipeuse avait été rognée se situait respectivement à 1 112 et 612 individus dans tout le bassin. Le pourcentage total de l'échappé provenant de la pisciculture (individus margués et intacts) a été estimé en augmentant le nombre observé de saumons à nageoire adipeuse rognée du taux de rognage de la nageoire adipeuse au moment du lâcher. En 1989, ce pourcentage s'élevait à 87, 1 % et à 100, 0 % chez les mâles et les femelles, respectivement, et en 1990, ces pourcentages étaient de 53, 0 % et de 62, 2 %. Ces estimations du pourcentage de quinnats issus d la pisciculture ont été comparées à celles obtenues par traitement des données sur les étiquettes métalliques condées utilisées dans le cadre du programme de récupération d'étiquettes. Selon cette méthode, le pourcentage total de quinnats issus de la pisciculture en 1989 se situait à 78, 9 % et 80, 3 % dans le cas des mâles et des femelles, respectivement; en 1990, ces pourcentages atteignaient 49, 4 % et 56, 4 %.

Mots-clés: Campbell, Quinsam, quinnat, cours d'eau clé, échappée, étiquettes métalliques codées, étiquetage de poissons vivants, étiquetage de carcasses.

INTRODUCTION

The chinook salmon of the Campbell/Quinsam river system was selected as one of the indicator stocks for assessing the response of Pacific chinook salmon stocks to a new harvest management regime. The goal of the new management regime is to rebuild chinook stocks to historical levels. This "key stream" program began in 1984 in response to objectives set out in the Canada - U.S. Salmon treaty.

The major objectives of the key stream program are:

1. to accurately estimate chinook escapement on key streams;

2. to estimate harvest rates and contributions to fisheries and escapement based on coded wire tagged/adipose clip returns, including estimates of the total escapement of coded wire tags to the key streams system; and

3. to estimate the contribution of hatchery and natural production to the escapement.

Chinook escapements to the Campbell River have ranged from 750 to 8,000 since 1947 (Shardlow et al. 1986). Chinook escapement to the Quinsam River was negligible prior to the opening of Quinsam Hatchery in 1972, but has increased from 1,500 in 1985 to 5,300 in 1988 (Andrew et al. 1988, Bocking et al. 1990). Chinook returns to the Quinsam Hatchery have also increased from 1800 in 1986 to 5200 in 1988 (Bocking et al. 1990).

This manuscript report is the fourth in a series describing the escapement monitoring and biological sampling of chinook salmon in the Campbell/Quinsam system. The 1984 study results are presented in Shardlow et al., 1986, 1985 results are in Andrews et al., 1988, and the 1986-88 study results are described by Bocking et al. 1990.

The 1989-90 escapements of chinook salmon were calculated using the adjusted Petersen method (Ricker 1975) by tagging carcasses to produce separate estimates for sexes and rivers and summing these to form a total estimate for the in-river escapement of chinook. The total recovery of chinook salmon at the Quinsam Hatchery was then added to the in-river estimates to produce a final escapement figure for the entire Quinsam/Campbell system. In 1989, the escapement of chinook to the Quinsam/Campbell system was also estimated using the adjusted Petersen method by tagging live chinook salmon in the Campbell River estuary and recovering the tagged chinook either as carcasses in the Campbell and Quinsam rivers, or as live recoveries at the Quinsam Hatchery. Extensive predation by seals in the Campbell River estuary during the 1989 tagging program prompted the abandoning of the live tagging method for estimating population size in 1990.

In this report, potential biases in the Petersen method, and the carcass tagging and live tagging approaches, and method of stratification are discussed. Assumptions for the methods used and the tests for biases caused by violations of assumptions are also described in the methods section. The results section presents the population estimates, tests for bias in tagging and recovery, population composition (age, length, and sex) and the results of coded wire tagging studies. The results are then discussed with respect to other studies and recommendations are made regarding future studies.

To avoid confusion in terminology relating to tagging and marking, the word "tagging" in this report refers to operculum tagging of live or dead mature chinook in the river and "marking" refers to marking of chinook juveniles with coded wire tags (CWT) and adipose fin clips (AFC).

STUDY AREA

The physical attributes of the Quinsam/Campbell drainage area have been described in detail by Andrew et al. (1988). The Campbell River originates east of the Vancouver Island Ranges and flows in an easterly direction for 9 km into Discovery Passage immediately north of the city of Campbell River, British Columbia (Figure 1). The Quinsam River, a major tributary of Campbell River, flows in a northerly direction through a series of small lakes for over 30 km to its confluence with the main Campbell River approximately 3.8 km upstream of its mouth.

The drainage area of the Campbell River system is 1,460 km^2 and of the Quinsam River system is 265 km^2 (Andrews et al. 1988). Fish passage in Campbell River is blocked by natural falls and a hydroelectric dam 5.5 km upstream of the mouth. Approximately 27 km of the Quinsam are accessible to natural spawning but chinook spawning takes place primarily in the lower 4 km of the river (Shardlow et al. 1986). In 1988 and future years, more access for chinook salmon to the upper Quinsam River will be provided past the counting fence near Quinsam Hatchery.

Flows in the Campbell River are controlled by the John Hart Generating Station, located 5.5 km upstream of the mouth (Marshall et al. 1977) and vary from 1.2 m^3s^{-1} to 826.0 m^3s^{-1} (mean=96.0 m^3s^{-1}). Flows on the Quinsam are not controlled and vary from 0.9 m^3s^{-1} to 21.6 m^3s^1 (mean=9.0 m^3s^{-1}) (Shardlow et al. 1986).

Commercial development in the Campbell River estuary includes log booming, sawmills, shake mills, a seaplane base at Tyee Spit, and pleasure boat moorage (Andrew et al. 1988). Manmade islands have been constructed in the estuary in an effort to improve fish habitat (Levings 1986). The lower reaches of the Campbell have been modified due to expansion of the community of Campbell River (population approximately 18,000) which surrounds the lower 2 km of the river. Access to the Campbell is primarily by municipal roads and by the Campbell River Road, which runs along the south bank of the river.

Mining for coal is conducted in the headwaters of the Quinsam, and forest harvesting is conducted throughout the watershed (Andrew et al. 1988). There is easy access to the lower reaches of Quinsam River but upstream of the hatchery, access is more difficult (i.e. logging roads).

The Campbell/Quinsam river system supports five species of Pacific salmon as well as steelhead trout (*Oncorhynchus mykiss*) and cutthroat trout (*O. clarki*). The salmonids, in order of abundance, are pink, chinook, chum and coho salmon (*O. gorbuscha, O. tshawytscha, O. keta, O. kisutch*, and *O. nerka*, respectively). Chinook spawn in Campbell River upstream of the confluence with the Quinsam, and in the Quinsam from the mouth to the counting fence (Andrew et al. 1988). Each year some chinook salmon swim through the counting fence to spawn in the upper Quinsam River or are passed over the fence by hatchery staff. Coho spawn in the Quinsam River, but not the Campbell, and chum and pink salmon that used to only spawn in the lower reaches of the Campbell now utilize

the lower reaches of Quinsam River as well. Chinook start migrating into the Campbell in late August but mainly in October, and peak spawning occurs from mid-October to mid-November (Andrew et al. 1988, Van Tine, pers. comm.[2]). Migration of chinook into the Quinsam is greatly influenced by rainfall, but usually occurs from late September to late November. Spawning is usually completed by late November or early December.

The Quinsam Hatchery is located approximately 3.7 km upstream of the confluence with the Campbell River. A fence is located immediately upstream of the hatchery for broodstock collection (Figure 1). Fish distribution and smolt production, as well as river flows and water quality in the watershed were studied by Blackmun et al. (1985).

METHODS

Carcass tagging and recovery was conducted from mid-October to late November of each year by Quinsam Hatchery workers. In 1989, live tagging of chinook in the Campbell River estuary commenced in mid-August. A summary of methods for this study is presented in Table 1 and is described below.

POPULATION ESTIMATION

Chinook salmon were enumerated using the adjusted Petersen method (Ricker 1975, p. 78) by tagging chinook carcasses following natural spawning and recovering tags from the carcasses. In both years, carcasses were tagged and recovered in situ. In 1989, an additional escapement estimate was derived using the adjusted Petersen method by tagging live chinook salmon in the Campbell River estuary and recovering tags from carcasses in the rivers and from live chinook recovered at the Quinsam Hatchery.

Population Stratification

Carcass Tagging:

There are four main ways of stratifying the carcass tagging and recovery data to produce a Petersen estimate of escapement:

1. sexes and rivers pooled;

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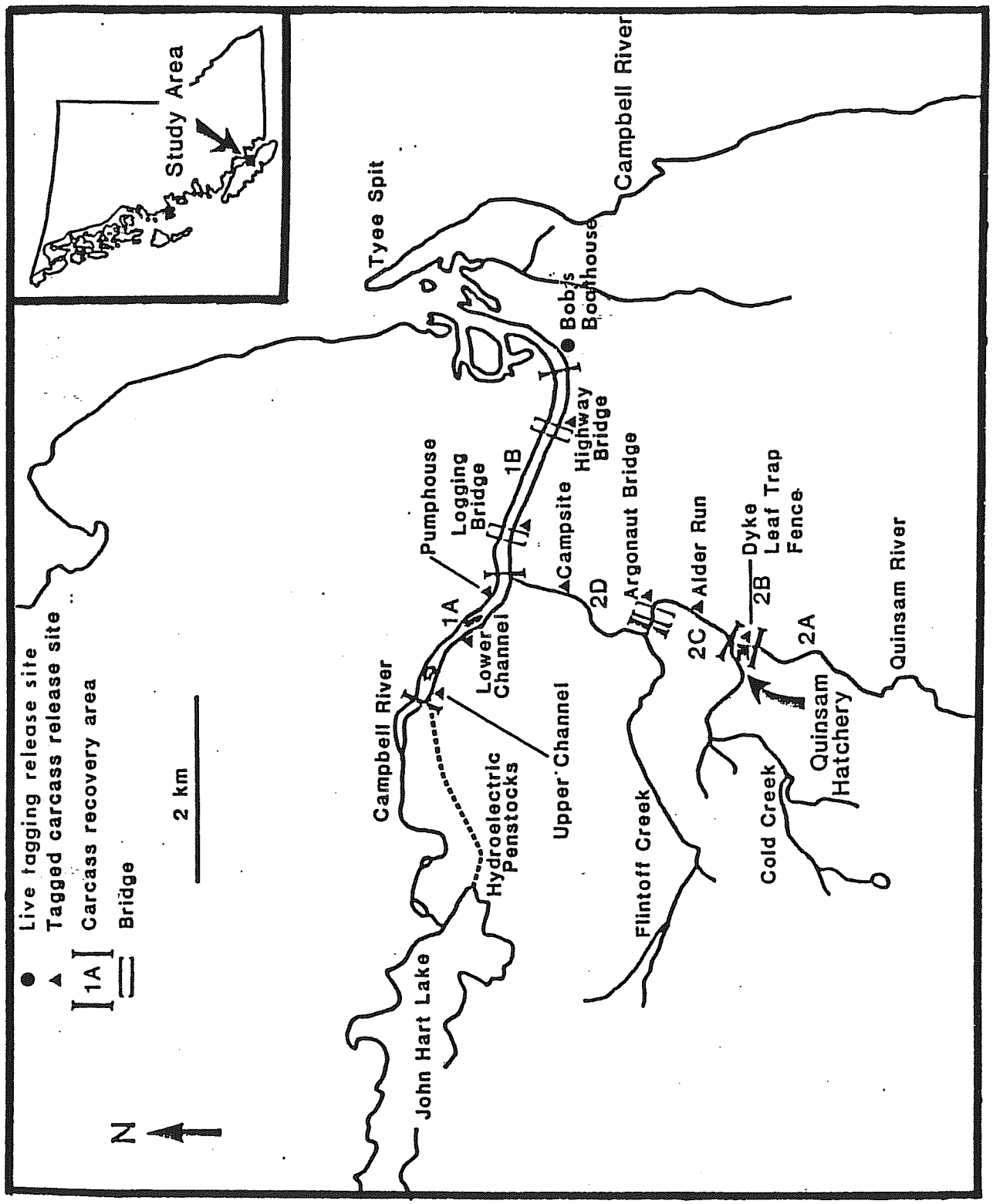

Figure 1. Map of the Campbell and Quinsam rivers study area.

2. sexes separate with rivers pooled;

3. sexes separate and rivers separate; and

4. sexes pooled with rivers separate.

Separate Petersen estimates may be calculated for each stratum and then summed to obtain an estimate of the whole population. By segregating the data into separate population strata, potential biases created by factors which affect the strata at different rates may be avoided. The main factors of concern are rates of tag application, recovery of carcasses, and tag loss. If carcasses in the Campbell and Quinsam rivers do not mix following release of tagged carcasses in each river, forming two distinct groups for the purpose of enumeration, then there is a potential for substantial bias in unstratified estimates if tagging or dead recovery rates and effort are not identical. Similarly if the two sexes (and jacks) have different rates of tag application, recovery rates, or tag loss, then a single population estimate may be biased.

Due to the likelihood of factors affecting sexes and rivers at different rates, as documented by Andrew et al. (1988), Petersen estimates were stratified by sex and river in this study. Petersen estimates were generated for the Campbell River and the Quinsam River (below the fence). Additional counts of chinook salmon returning to the hatchery rack and those fish passing upstream through the Quinsam River fence were added to the two Petersen estimates to give a total system escapement.

Live Tagging:

Live tagging in 1989 was designed to provide a single estimate of chinook escapement to the entire Quinsam/Campbell river system. Live tagging Petersen estimates were stratified by sex for the reasons mentioned above, but could not be stratified by river.

Potential Biases

Carcass Tagging:

Within a stratum, Petersen estimates using carcass tagging are potentially biased by violation of a number of assumptions. Seven of these assumptions were discussed in Andrew et al. 1988 and Bocking et al. 1990. and are repeated in this paper for the benefit of those only reading this manuscript.

Tests used to determine whether biases were acting in this study are also presented and discussed below with respect to sex and river stratification of the Petersen estimate. Certain biases caused by methods of tagging, recovery, age determination, etc. are discussed in subsequent sections.

1. Tags are consistently applied in proportion to the available population and/or the distribution of recovery effort is proportional to the number of fish present in different river reaches and/or tagged fish become randomly mixed with untagged fish.

To obtain an accurate Petersen estimate, it is important to apply and/or recover tags in proportion to the available population. In 1989-90, carcasses were tagged sequentially and in situ during recovery. Hatchery workers attempted to tag a consistent proportion of the number of fish examined during each recovery survey by tagging every second untagged carcass in 1989 and every fifth carcass in 1990, although this proportion still tended to vary considerably (usually 20 - 60%) between days depending on the number of tagged carcasses recovered.

A related problem associated with rivers-separate escapement estimates is that tagged fish may stray (washout) between rivers. Apart from passive movement due to water flow, tagged carcasses are not subject to movement or straying in the same way as live fish. Calculations related to straying are described below. It is not possible to statistically test the extent of mixing of marked and unmarked fish using the data from this study, but movements of tagged fish are indicated by the location of recovery relative to the location of tagging. Individual tag release and recovery locations were grouped into river reaches to facilitate this comparison.

2. There is a negligible influx of spawners after the conclusion of tagging.

An influx of spawners following tagging could cause the Petersen calculations to overestimate or underestimate the true population depending on how they mixed with tagged fish. In 1989 and 1990, tagging continued in situ in the rivers almost daily throughout the spawning and die-off period. The exception to this was a 10 day period between November 9 and November 20, 1990, when flood conditions prevented field operations. However, because this flood period occurred during peak die-off, after the majority of chinook had already entered the stream, this phenomenon likely did not seriously bias the Petersen population estimates. This is hypothesis is further supported by the recapture on November 20 and 22 of carcasses tagged prior to the flood.

3. There is no tag loss.

A high incidence of tag loss will cause Petersen calculations to overestimate the true population. Tag loss was determined by a hole punch in the operculum of all tagged carcasses. A different number of opercular holes was used to distinguish carcasses tagged in the Campbell River from carcasses tagged in the Quinsam River. All secondary marks (opercular punches) were included in the tag recovery data and Petersen estimates.

4. All tags are recognized and reported on recovery after the conclusion of tagging.

In this study, no repitches were conducted to reexamine deadpitch carcasses for missed tags and secondary marks, therefore it was not possible to evaluate tag non-reporting incidence.

5. Recovery efforts are made on the same population that was tagged.

Dead recovery from a population other than the tagged population will cause Petersen calculations to overestimate the true population. Indications that tagging and recovery were conducted on different populations would be different age frequency and length frequency distributions among the two samples. Since tagging occurred concurrently with recovery, this is not likely a problem.

6. There is adequate sampling to provide an accurate and precise population estimate.

A small number of tag recoveries in a stratum will cause Petersen estimates to have low precision. Petersen estimates are generally more reliable if a high proportion of tagged fish are recovered in each stratum. In the absence of other sources of bias, approximately 25 to 75 recaptures will produce population estimates with 25% accuracy, and 95% confidence, for populations of 10^2 and 10^9 (Ricker 1975). Confidence intervals for the escapement estimates were calculated as described later in the calculations section of the methods.

7. Tagged carcasses are representative of the population and behave in a similar manner to untagged carcasses with respect to buoyancy, visibility, and decomposition.

Tagged carcass recoveries will not be representative of the population if tagged carcasses do not mix completely with untagged ones (see assumption 1), in which case the Petersen method may overestimate or underestimate the population. The thoroughness of mixing depends on whether tagged carcasses behave in a similar manner to untagged carcasses. It is not possible to statistically test the assumption of mixing with the data from this study.

Buoyancy and decomposition may be important factors causing differential behaviour of tagged and untagged carcasses especially if tagged carcasses become bloated with air during handling. Differences in tag visibility could cause preferential sampling of tagged carcasses, and result in an underestimate of the population. An attempt was made to circumvent this problem by using neutral colours to prevent increased visibility of tagged carcasses. It is not possible to test the assumption of similar visibility between tagged and untagged carcasses with the data from this study. The assumption of similar buoyancy and decomposition of tagged and untagged carcasses could be tested by comparing the tag recovery rate in the dead recovery with the rate at carcass weirs if such data were available.

Live Tagging:

All of the above-mentioned assumptions apply to the live tagging of chinook in 1989. However, the potential for violation of some of these assumptions may differ from carcass tagging.

Assumption 1: Tags applied proportionally or recovery effort proportional to distribution of fish.

There was no way of testing whether the initial tagging of live chinook in the estuary was in proportion to the total population, although the tagging period coincided with the presumed period of migration (mid-August to mid-October). For live tagging, the recovery effort was spread over the entire river system (including the hatchery) and the dead recovery effort was spread over the period of die-off. As much as possible this recovery effort was in proportion to the available population.

Assumption 2: Negligible influx of spawners after tagging completed.

Live tagging was spread over a 7 week period from August 23 to October 16. The recovery of chinook carcasses in the river and live chinook at the hatchery rack continued for another 6 weeks. It is possible that additional untagged spawners could enter the river after the end of live tagging operations. If this were the case, then the recovery of tags would not be of constant proportion to the

total population throughout the tagging period. Since no live tags were recovered prior to the termination of live tagging, this assumption could not be tested.

Assumption 3: No tag loss.

Tag loss for live chinook was determined by opercular hole punching all tagged chinook with a hole combination distinct from the carcass tagging. Recoveries of secondary marks for the live tagging were included in the Petersen estimates to ensure that this assumption was not violated.

Assumption 7: Tagged chinook behave similarly to untagged chinook.

No tests were made to quantify mortality rates, visibility, and detectability between tagged and untagged chinook. However, observations during tagging in 1989 suggested that seal predation could have been high for tagged fish as they were released back into the water.

Calculations

The adjusted Petersen estimate of each river stratum and sex was calculated as follows (Chapman's formula, cited in Ricker 1975, p. 78):

$$P_{i,r}=\frac{(C_{i,r}+1)(M_{i,r}+1)}{(R_{i,r}+1)} \quad (1)$$

where P is the population estimate, C is the total number of fish recovered, M is the total number of fish tagged, and R is the number of tagged fish recovered and includes fish with missing tags (secondary marks only). The subscript i is the sex stratum and the subscript r is the river stratum.

Population estimates for sex and river (carcass tagging only) strata were summed to obtain a total in-river population estimate:

$$P_t=\sum_{i=1}^{n}\sum_{r=1}^{m}P_{i,r} \quad (2)$$

where n is the total number of sex strata (2) and m is the total number of river strata (2).

Confidence limits for each stratum population estimate were obtained using fiducial limits for the Poisson distribution as described by Ricker (1975, p79). The 95% confidence limits for the total escapement was then determined by assigning equal weights to all strata and summing the lower and upper confidence limits across strata.

Strays

In this study, tagged carcasses released in one river and recovered in the other river were considered to be strays. For the purposes of the carcass tagging Petersen calculations, the total number of strays from the Quinsam River (Q) to the Campbell River (C) was estimated by expanding the observed number of tagged strays as follows:

$$ES_{Q\ to\ C} = TS_{Q\ to\ C} \times (M_{Campbell} / R_{Campbell}) \quad (3)$$

where ES is the expanded number of strays, TS is the number of tagged strays, M is the number of secondary marks applied and R is the number of secondary marks recovered.

No straying occurred from the Campbell River to the Quinsam River. This expanded number of tagged strays from the Quinsam to the Campbell was then used to estimate the number of tagged fish available in the Campbell River:

$$M'_{Campbell} = M_{Campbell} + ES_{Q\ to\ C} - ES_{C\ to\ Q} \quad (4a)$$

where M' is the adjusted number of marks applied.

The above equation provides the adjusted estimate for the number of tagged fish available for recapture ($M_{i,r}$) used in equation 1. Tagged fish available for recaptures in Quinsam River is then:

$$M'_{Quinsam} = M_{Quinsam} + ES_{C\ to\ Q} - ES_{Q\ to\ C} \quad (4b)$$

TAGGING

Tagging was conducted in tandem with the dead recovery effort. This enabled the tagging effort to be spread evenly throughout the recovery period (Appendices A3, A4, B3, B4).

RECOVERY

Sampling crews that conducted the dead recovery were composed of two to six workers each day. Tables 2-3 show the number of days spent in dead recovery effort for each area in each river. Recovery effort in 1989 was higher than in 1990 because of extensive flooding in 1990 which suspended field operations for approximately 10 days.

Recovery crews were instructed to dead pitch and count all available carcasses and record and keep all operculum tags. In both years, crews attempted to keep recovery effort as complete and consistent as possible throughout the study period. Dead chinook were recovered from the Campbell and Quinsam rivers by two methods:

1. recovery crews searched the banks and shallow reaches of the rivers on foot and from a boat; and

2. a SCUBA diver recovered carcasses from deep pools in the lower reaches of the Campbell and Quinsam rivers.

Chinook were also recovered live at the Quinsam Hatchery rack.

Each carcass was examined for the presence of a cattle ear tag, opercular punch hole and missing adipose fin. Heads were removed from adipose clipped fish for sampling of CWTs. Data collected from the carcasses is described in the biological and physical sampling methods section. All carcasses tagged during the recovery effort were released at the same location as they were tagged. All recaptured tagged carcasses were cut in half to prevent recounting in future dead pitches.

For the purposes of the Petersen mark-recapture estimates, only carcasses recovered after the first day of tagging were included in the values of C and R. It was assumed that one day was necessary to allow sufficient mixing between tagged and untagged carcasses.

Other calculations relating to the dead recovery were as follows:

$$\textit{tag rate} = R / C \tag{5}$$

where *tag rate* is an estimate for the proportion of the population tagged.

$$\textit{tag recovery rate} = R / M \tag{6}$$

where *tag recovery rate* is an estimate of the proportion of tagged fish recaptured.

BIOLOGICAL AND PHYSICAL SAMPLING

Biological sampling during dead recovery included scales for age determination, length, sex, presence of secondary marks (hole punches in opercular) and presence of an adipose clip. Postorbital-hypural length was recorded from 55-60% of the carcasses (marked and unmarked fish) recovered in the Campbell River, 19-31% of the carcasses recovered in the Quinsam River, and 20-21% of the chinook recovered alive at the hatchery rack. Males were considered to be jacks when their length was less than 550 mm, however, some small males were incorrectly classified as jacks. Because of this problem and because of small sample sizes for jacks, length data on jacks was grouped in with adult males.

Scale samples were taken from the same unmarked fish as length samples. Some adipose clipped fish (CWT) were also sampled for age (from decoding) and lengths. A scraping of scales was placed in a labelled plastic envelope and the individual scales from each fish were mounted in scale books at the hatchery. Scales were aged at the Department of Fisheries and Oceans scale laboratory in Vancouver. Heads were removed from adipose clipped fish and saved for CWT extraction and decoding at the coded wire tag dissection laboratory in Vancouver.

Ages were read only when a portion of the previous annulus was present and scales were not regenerated. Scales were classified as unreadable if the scales had regenerate centres, they were resorbed, or if they were mounted upside down. Ages were recorded for fish for which there were at least two scales that could be read for both marine and freshwater ages. In this report, the first numeral of the age recorded indicates the year of total life and the decimal point and following numeral indicates the year of life in which the fish migrated to the ocean. The aging system follows that described by Gilbert and Rich (1927).

The age composition determined with the available samples is valid only if age sampling was random and there was no bias in readability of scales with age. Ages of older fish are usually more difficult to read than those of young fish because scales of older fish usually undergo more resorption and regeneration. The data were examined for this potential bias using a t-test to compare the mean lengths of known and unknown age males and females. The dead recovery sample was used to determine the age and length composition of the population. Because of problems in distinguishing jacks from adult males, age and length information for jacks was grouped with males.

The population of each age class was then determined by allocating portions of the Petersen estimate to age classes according to the age composition determined from scale samples.

The sex ratio was determined for each river by sexes and rivers-separate Petersen estimates. This method provides a valid sex ratio. The test for potential differences in tag loss was described in the tagging methods section. Tag recognition is not likely to be biased by sex, although it was not possible to test this potential bias with the data in this study.

CODED WIRE TAGGING AND RECOVERY

Juvenile chinook from the 1983 - 1988 brood years were marked at Quinsam Hatchery with binary coded wire tags (CWT) described by Jefferts et al. (1963) using standard methods (Armstrong and Argue 1977). Adipose fins of coded wire tagged juveniles were clipped prior to release of the fish.

The estimation of the contribution of hatchery reared chinook to the total escapement utilizes the adipose or CWT mark rate in the escapement. Two different approaches were used to determine the contribution of hatchery released chinook, by tag code, to the escapement. In the first approach, we used the live and dead recovery samples to estimate the total number of adipose clipped fish (AFC) in the escapement, stratified by river and sex (Method A). In the second approach, we used the live and dead recovery samples to estimate the total number of CWT fish in the escapement (Method B). It should be noted that expansions by the Mark Recovery Program for commercial and sport fisheries use Method B and, therefore, adipose clip expansions for escapements using Method A are not directly comparable.

Method A

Adipose clipped fish were enumerated separately for males and females in the Campbell River, Quinsam River and Quinsam Hatchery. Quinsam Hatchery recoveries included fish examined and released upstream of the counting fence. The recovery of jack chinook was included with the adult

male recoveries in this analysis. The first step was to estimate the number of adipose clipped fish in each stratum (river and sex) from the observed number of adipose clips:

$$EAD_{i,r}=\frac{OAD_{i,r}\cdot P_{i,r}}{C_{i,r}} \tag{7}$$

where *EAD* is the estimated number of adipose clips, *OAD* is the number of adipose clips observed, *C* is the number of fish examined, *P* is the population estimate, and *i* and *r* are subscripts denoting sex and river location (stratum). The sex specific population estimates used here were from the Petersen population estimates for the Campbell and Quinsam Rivers and from direct counts for the hatchery.

Given an estimate of the total number of adipose clips for each sex escaping to each portion of the system, the number of adipose clips for each tag code can be estimated by the allocation of adipose clips to tag code groups based on their relative frequency in the sample of decoded tags:

$$EAD_{i,r,tc}=\frac{EAD_{i,r}\cdot NDT_{i,r,tc}}{SumNDT_{i,r}} \tag{8}$$

where *tc* is a subscript denoted tag code, *NDT* is the number of successfully decoded tags for each tag code, and *SumNDT* is the total number of decoded tags for all tag codes, for each strata and sex.

This approach of first estimating adipose clipped fish and then allocating these among the successfully decoded CWTs assumes that any adipose clipped fish not decoded (i.e. no pins) were once marked but lost their coded wire tag for some reason. If this assumption is incorrect, the calculation of the number of hatchery origin fish using this method would be positively biased. It is possible, especially in the dead pitch, that some fish identified as hatchery releases by missing adipose fins may be fish that have naturally lost their adipose fins through some other means, e.g. carcass decomposition, or were misidentified. However, if decomposition of adipose fins is occurring then the adipose mark rate (based on hatchery contributions only) in the dead pitch should be higher than the mark rate at release. Other potential sources of bias using Method A are discussed in Bocking (1991).

The hatchery contribution to each year's escapement, stratified by river and sex, was calculated by expanding the estimated number of adipose clips from each tag code group in proportion to the percentage of juvenile fish having an adipose clip at time of release:

$$EHC_{i,r,tc}=\frac{EAD_{i,r,tc}\cdot(RC_{tc}+RUC_{tc})}{RC_{tc}} \tag{9}$$

where *EHC* is the estimated hatchery contribution, *RC* is the number of chinook released with an adipose fin clip for each tag code group (*tc*), and *RUC* is the number of chinook released without an adipose fin clip for each tag code group (*tc*).

These estimates of hatchery contributions, stratified by brood year (*t*), river (*r*), sex (*i*) and tag code (*t*) can then be summed to give the hatchery contribution of all tag codes to the entire escapement:

$$EHC=\sum_{t=1}^{j}\sum_{r=1}^{k}\sum_{i=1}^{m}\sum_{tc=1}^{n} EHC_{t,r,i,tc} \tag{10}$$

where *n* is the number of tag codes for a given brood year *t*.

Due to the potentially different ages at maturity of males and females, it is important that the allocation of adipose clipped fish to tag codes be carried out separately by sex whenever possible. In this study, the sex of all fish sampled for CWTs was recorded so that it was possible to estimate the total escapement of tag codes by sex (males included jacks). Final hatchery contribution estimates were made separately for fish of Quinsam origin and for strays from other rivers.

Method B

In the second approach used to estimate the hatchery contribution, we estimated the number of successfully decoded CWT chinook in the escapement, stratified by river and sex using the methods described for the Mark Recovery Program (Kuhn et al. 1988). The primary difference between this method and Method A is that Method B uses the number of actual CWTs present in the escapement from which to derive the hatchery contribution, whereas Method A uses the number of adipose clips present in the escapement. This method is currently used by DFO to estimate hatchery contributions in commercial and sport chinook catches.

Estimating the total number of CWT returns from each of the brood years, and for each tag code was done as follows.

First, the observed number of CWT recoveries was adjusted to account for "no pin" (no tag) recoveries:

$$ADJ_{i,r,tc}=OBS_{i,r,tc}\cdot\left[1+\frac{LP}{K}+\frac{ND\cdot(K+LP)}{K\cdot(K+LP+NP)}\right] \tag{11}$$

where *ADJ* is the adjusted number of observed CWT fish, *OBS* is the observed number of CWT fish, K is the sum of all successfully decoded tags for all tag codes recovered, *LP* is the number of lost pin recoveries, *ND* is the number of no data recoveries, *NP* is the number of no pin recoveries, and *i*, *r*, and *tc* are subscripts denoting, sex, river, and tag code.

This adjusted number of CWT recoveries was then used to estimate the total number of CWT returns for each tag code:

$$EST_{i,r,tc}=\frac{ADJ_{i,r,tc}\cdot P_{i,r}}{C_{i,r}} \tag{12}$$

where *EST* is the estimated number of CWT recoveries for a single tag code, *C* is the number of fish examined, *P* is the population estimate, and *i*, *r*, and *tc* are subscripts denoting sex, river, and tag code.

This approach of estimating the number of CWT chinook in the escapement assumes that any adipose clipped chinook found without CWTs were never marked. This assumption is only valid if chinook tagged with a particular tag code did not lose the CWT after release from the hatchery (i.e. after accounting for tag loss during a retention test). Since it has been demonstrated that CWT fish can lose up to 90% of their tags within 4 weeks of tagging (Blankenship 1990), any fish that have been released within this 4 week period are likely to continue to have some tag loss prior to being recovered in the fishery or escapement. Violation of the assumption of no tag loss will result in a negative bias in the hatchery contribution estimates. Other potential sources of bias using Method B are discussed in Bocking (1991).

The hatchery contribution to each year's escapement, stratified by river location and sex, was calculated by expanding the estimated number of CWT fish of each tag code group in proportion to the percentage of juvenile fish having a CWT at time of release:

$$EHC_{i,r,tc}=\frac{EAD_{i,r,tc}\cdot(RM_{tc}+RUM_{tc})}{RM_{tc}} \tag{13}$$

where *EHC* is the estimated hatchery contribution, *RM* is the number of chinook released with CWTs for each tag code group (*tc*), and *RUM* is the number of chinook released without CWTs for each tag code group (*tc*).

As for Method A, these estimates of hatchery contribution by tag code were then summed to give the hatchery contribution of all tag codes to the entire escapement, stratified by river, sex and brood year:

$$EHC=\sum_{t=1}^{j}\sum_{r=1}^{k}\sum_{i=1}^{m}\sum_{tc=1}^{n} EHC_{t,r,i,tc} \quad (14)$$

where n is the number of tag codes for a given brood year t.

Percent hatchery contributions by sex and age were then calculated using the Petersen population estimates.

RESULTS

TAGGING

Carcass Tagging

In 1989, 391 chinook carcasses were tagged and released continuously throughout the spawning period from October 17 to November 22 in the Campbell River and 1772 carcasses were tagged and released from October 16 to November 30 in the Quinsam River (Table 4; Appendix A1 and A2).

In 1990, 271 chinook carcasses were tagged and released continuously throughout the spawning period from October 18 to November 21 in the Campbell River and 582 carcasses were tagged and released from October 18 to November 22 in the Quinsam (Table 5; Appendix B1 and B2).

Live Tagging

In 1989, between August 23 and October 16, 493 live chinook were captured and tagged near Bob's Boathouse in the Campbell River estuary using a small boat seine (Appendix A3). Fish were tagged in proportion to their catch rates.

RECOVERY

Surveys to recover carcasses in 1989 began on October 19 in the Campbell River and on October 18 in the Quinsam River and continued until November 24 and 30, respectively (Appendix A4 and A5; Fig. 1). In 1990, chinook carcasses were recovered from October 18 to November 21 in the Campbell River, and from October 18 to November 22 in the Quinsam River (Appendix B3 and B4). On some days, some reaches in each river were surveyed more frequently than others. The

number of carcasses recovered in each area of the rivers for each year are summarized in Appendices A4, A5, B3, and B4.

Sequential daily totals of the number of carcasses recovered, the number of tags applied, and the number of tags recovered, stratified by year, river, and sex are presented in Appendix A6, A7, B5, and B6. Note that the total number of fish examined is greater than the number of fish examined (C) in the Petersen formula because recoveries on or before the first day of tagging cannot be included. Subsequent references in this report to the number of carcasses recovered are for the number of recoveries used in the Petersen estimate.

In 1989, a total of 844 chinook carcasses were examined in the Campbell River (343 males, 499 females, and 2 jacks; Table 4). This number included 171 tag recoveries (54 males, 117 females and 0 jacks). There were a total of 8 male and 14 female strays from the Quinsam River (Table 6). In the Quinsam River, a total of 4176 chinook carcasses were examined (1860 males, 2272 females, and 44 jacks; Table 4). This included 1154 tag recoveries (405 males, 749 females, and 0 jacks). In both rivers, more females than males were recovered, and fewer jacks were retrieved than either males or females.

In 1990, 664 chinook carcasses were examined in the Campbell River (320 males, 333 females, and 11 jacks; Table 5). This included 63 tag recoveries (29 males, 34 females and 0 jacks). There were a total of 9 male and 7 female strays from the Quinsam River (Table 6). In the Quinsam River, a total of 3097 chinook carcasses were examined (1277 males, 1836 females, and 24 jacks; Table 5). This included 238 tag recoveries (86 males, 152 females, and 0 jacks). As in 1989, and in both rivers, more females than males were recovered, and fewer jacks were retrieved than either males or females.

The carcass tag recovery rate in the Quinsam River was higher in 1989 (65.1%) than in 1990 (40.9%) and for the Campbell River, the tag recovery rate was also higher in 1989 (43.7%) than in 1990 (23.2%) (Tables 4 and 5). These differences were significant (χ^2, $P < 0.001$) and are likely due to the frequent incidence of high water during 1990 which made the recovery of tags difficult. Tag rates were also significantly (χ^2, $P < 0.001$) higher in 1989 than in 1990 (Tables 4 and 5) due to the high water in 1990. Within each year, females tended to have slightly higher tag rates and tag recovery rates than males, but these differences were only significant in 1989 (χ^2, $P < 0.05$). Tag recovery rates were significantly higher in the Quinsam River than in the Campbell River (χ^2, $P < 0.001$).

The extent of straying between release locations, within each river strata, was evaluated by determining the percentage of tagged carcasses that were recovered outside of the area of tagging. In the Campbell River in 1989, 36.5% of the female carcasses tagged were recovered in the same area where tagging took place (i.e. area 1A or 1B, Figure 1), 1.9% were recovered outside the area of tagging but still in the Campbell River, and 61.5% were not recovered. The values for males were similar with 32.1% of the male carcasses tagged being recovered in the same area where tagging took place, 0% recovered outside the area of tagging, and 67.9% unrecovered.

In the Quinsam River in 1989, 31.5% of the female carcasses tagged were recovered in the same area where tagging took place (i.e. area 2B, 2C, or 2D, Figure 1), 7.7% were recovered outside the area of tagging but still in the Campbell River, 0.2% strayed to the Campbell River, and 60.8% were not recovered. The values for males were similar with 30.3% of the tagged male

carcasses recovered in the same area where tagging took place, 6.2% recovered outside the area of tagging but still in the Quinsam River, 0.1% recovered in the Campbell River, and 63.5% unrecovered.

In 1990, the extent of straying from the tagging area was even lower than in 1989, but the incidence of tag recoveries was considerably lower. In the Campbell River, 13.7% of the female carcasses tagged were recovered in the same area where tagging took place (i.e. area 1A or 1B, Figure 1), 0% were recovered outside the area of tagging but still in the Campbell River, and 86.3% were not recovered. The values for males were similar with 12.9% of the male carcasses tagged being recovered in the same area where tagging took place, 0.7% recovered outside the area of tagging, and 86.3% unrecovered.

In the Quinsam River in 1990, 24.4% of the female carcasses tagged were recovered in the same area where tagging took place (i.e. area 2B, 2C, or 2D, Figure 1), 4.4% were recovered outside the area of tagging but still in the Campbell River, 1.4% strayed to the Campbell River, and 69.7% were not recovered. The values for males were similar with 22.0% of the male carcasses tagged being recovered in the same area where tagging took place, 3.7% recovered outside the area of tagging but still in the Quinsam River, 2.8% strayed to the Campbell River, and 71.6% unrecovered.

A total of 9805 chinook (carcasses and live recoveries) were examined for "live" tags in the deadpitch and at the hatchery rack in 1989. Of these, 152 were tagged (Appendix A8, A9 and A10).

POPULATION ESTIMATES

Carcass Tagging

The parameter values used in the derivation of the Petersen escapement estimate, stratified by year, river, and sex are given in Tables 6 and 7. The 1989 chinook escapement to the Campbell River and Quinsam River, as estimated using a simple Petersen estimate from hatchery broodstock in situ carcass tagging, was estimated at 2186 and 6517 fish respectively (Table 6). Sex specific estimates and 95% confidence limits for both rivers are also shown in Table 6. The total escapement to the Campbell/Quinsam river system in 1989, including hatchery rack recoveries and fish counted above the Quinsam River fence, was estimated to be 14825 with 95% confidence limits of 14431 to 16698 fish.

The 1990 chinook escapement to the Campbell River and Quinsam River, was estimated to be 3446 and 6680 fish respectively (Table 7). The breakdown of these totals among sexes for both rivers are also shown in Table 7. The total escapement to the Campbell/Quinsam river system in 1990, including hatchery rack recoveries and fish passed above the Quinsam River fence, was estimated at 15538 fish with 95% confidence limits of 13439 to 18452.

The proportion of fish between the two rivers and the Quinsam Hatchery varied only slightly over the 2 years of this study. In 1989, the distribution was 14.7;44.0;41.3 (Campbell; Quinsam; hatchery). In 1990, the distribution between the Campbell, Quinsam and hatchery was 22.2;43.0;34.8. This indicates little change in the numbers of chinook returning to the Campbell

River since 1987 (Bocking et al. 1990) and an increase in the number of returns to the Quinsam River and hatchery (Figure 2). In both 1989 and 1990, returns to the hatchery included some fish netted in the lower Quinsam River and passed over the Quinsam River fence.

Live Tagging

The 1989 total chinook escapement to the Campbell/Quinsam system, as determined from live tagging, ranged from 25735 to 37674, depending on which recovery data were used (Table 8). Live recoveries at the Quinsam Hatchery only produced the lowest estimate while dead recoveries in the Campbell and Quinsam rivers produced the highest estimate. However, tag rates for the live tagging method were extremely low (< 2 %) compared to 7-20% for the carcass tagging method. These low tag rates suggest that there was unusually high loss of tagged fish. The tagging crew frequently observed seals in the tagging area and this may account for the lower tag rate in live tagging than in carcass tagging in 1989.

AGE, LENGTH AND SEX COMPOSITION

Virtually all (> 99%) of the fish aged in the Campbell and Quinsam rivers left the river to rear in the ocean during their first year of life (termed sub-ones in this report) (Tables 9 to 12). Total ages of Campbell and Quinsam river chinook ranged from 2 to 6 years. The dominant age-group in the Campbell River was age 5 years (both sexes) except in 1990 when returning males were predominantly age 4 (Table 12). In the Quinsam River, the dominant age class was 5 years in 1989 (both sexes) and age 4 for 1990 (both sexes). Male returns to the hatchery were predominantly age 3 in 1989 and age 4 in 1990 (Tables 11 and 14) while the dominant female age group was 5 year olds in 1989 and 4 year olds in 1990. These results indicate that the dominant age group for chinook returns to the Campbell/Quinsam system was lower in 1990 than in 1989.

Summaries of mean lengths by age are presented in Tables 9 through 14. In these tables, the total mean length (all ages) is weighted according to the number of fish sampled. Over the 1989-90 period, Campbell River males and females (mean postorbital-hypural length for males (801 - 807 mm) and females (829 - 837 mm) were generally larger than Quinsam River fish (males = 743 - 779 mm; females = 788 - 814 mm). T-tests were conducted to compare the mean lengths among sexes, among river strata and among years. Male chinook carcasses were significantly smaller than female carcasses in both years and for each river strata (Campbell, Quinsam, and Hatchery) ($P < 0.001$) except for those carcasses recovered in the Quinsam River in 1990 ($P = 0.52$). Carcasses recovered in the Campbell River were significantly larger than those recovered in the Quinsam River (both years, males and females, $P < 0.001$). Carcasses recovered in the Quinsam River were also significantly larger than chinook recovered at the hatchery (both years, males and females, $P < 0.001$). There were no differences in the mean length of chinook between years except in the Quinsam River where chinook recovered in 1990 were significantly larger than those recovered in 1989 ($P < 0.001$). However, females recovered at the hatchery were smaller in 1990 than in 1989 ($P < 0.001$).

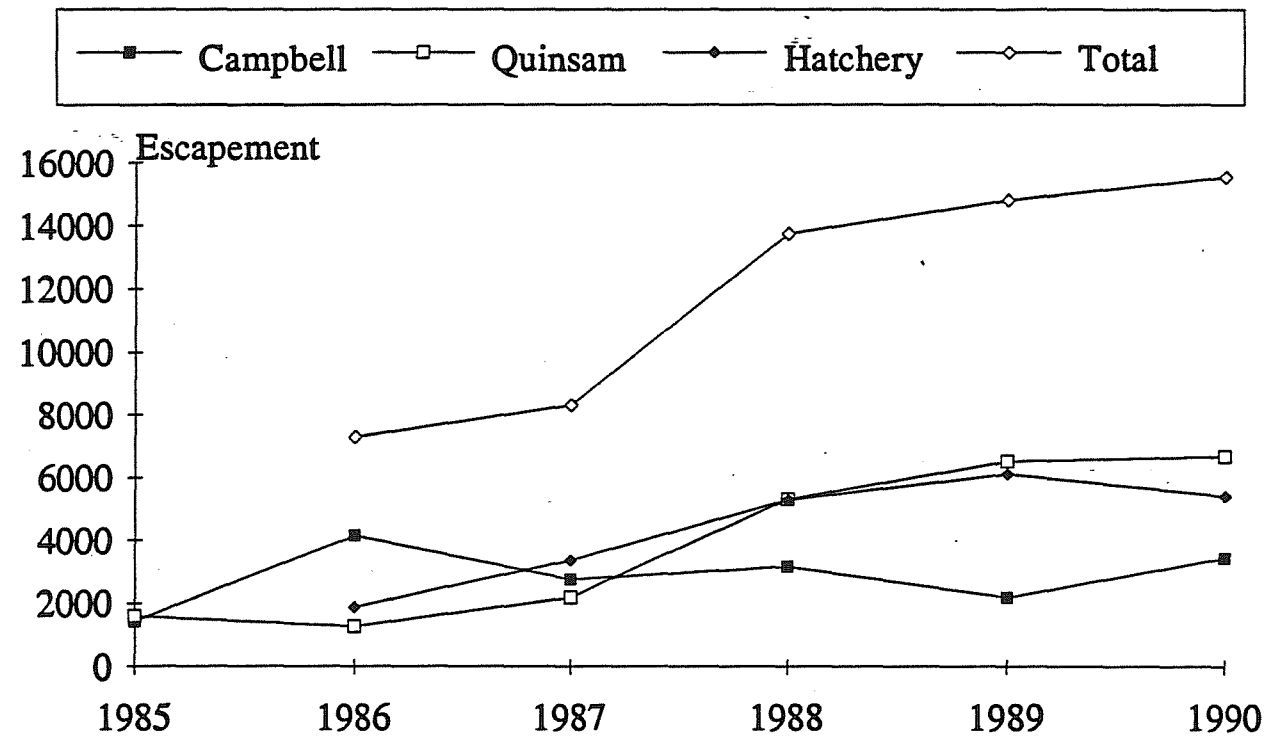

Figure 2. Chinook escapement estimates, stratified by river location, 1985 (Andrew et al. 1988), 1986-88 (Bocking et al. 1990), 1989-90 (this study).

There was no significant difference between the mean length of chinook that were not aged and the weighted (all ages) mean length of aged chinook for any combination of year, sex, and river stratum (t-test, $P > 0.05$). Age-length distributions for chinook returning to the Campbell River, Quinsam River, and Quinsam Hatchery in 1989 and 1990 are shown in Tables 15 and 16.

The population escapement, stratified by age class and sex, is shown in Tables 17 and 18 for Campbell/Quinsam river system chinook in 1989 and 1990, respectively. In 1989, the sex ratio of males (including jacks)/females was 0.77 in the Campbell River, 1.0 in the Quinsam River, and 1.52 in the Quinsam Hatchery (Table 17). In 1990, these sex ratios were 0.97 in the Campbell River, 0.75 in the Quinsam River, and 1.24 in the hatchery (Table 18).

CODED WIRE TAGGING AND RECOVERY

Coded wire tagged (adipose clipped) juvenile chinook released into the Campbell and Quinsam rivers from the 1983 to 1988 brood years were captured in the dead recovery programs in 1989 (Appendix A11 and A12) and 1990 (B7 and B8).

The results of coded wire tag returns are presented below for the Campbell and Quinsam rivers and the Quinsam Hatchery. Information includes the following:

1. the raw data and mark rates for the calculations; (Appendix A11, A12, B7, B8)
2. estimates of the total escapement of adipose clips; (Tables 19 and 20)
3. the observed and estimated escapement of adipose clips by tag codes, and the hatchery contribution to the escapement for each tag code; (Tables 21 to 25 and Tables 28 to 33)
4. the estimated hatchery contribution to the escapement by age class. (Tables 26, 27, 34, 35)

In 1989, there were 65 adipose clipped chinooks recovered in the Campbell River dead pitch, 358 in the Quinsam River dead pitch, 17 recovered upstream of the counting fence and 343 at the hatchery rack (Table 19). The adipose clip mark rate was highest in the Quinsam River returns (8.5%) and was lowest in the above fence returns (5.4%). The total estimated adipose clips to Campbell River, lower Quinsam River, upper Quinsam River, and Quinsam Hatchery were 164, 537, 68, and 343, respectively.

In 1990, there were 26 adipose clipped chinooks recovered in the Campbell River dead pitch, 137 in the Quinsam River dead pitch, and 123 at the hatchery rack (Table 20). (There were no recoveries above the fence in 1990.) The adipose clip mark rate was highest in the Quinsam River returns (4.3%) and was lowest in the hatchery returns (3.5%). The 1990 mark rates at return were substantially lower than the mark rate at return in 1989. The total estimated adipose clips to Campbell River, Quinsam River, and Quinsam Hatchery were 134, 287, and 191, respectively.

These mark rates at return were tested for significant differences between river strata and years using chi-square tests. The mark rates for the Campbell River, Quinsam River and Quinsam Hatchery were significantly different (χ^2, $P < 0.02$). The mark rates were also significantly higher (χ^2, $P < 0.02$) in 1989 than in 1990 for all areas.

Hatchery Contributions - Method A

Results from the decoding of adipose clipped fish from the Campbell and Quinsam river dead pitch and returns to Quinsam Hatchery are shown in Tables 21 and 22. For the hatchery contribution estimates, chinook above the Quinsam River counting fence were included in the Hatchery stratum. Any CWT fish recovered in the system which were released from another enhancement facility were included in the analysis (4 strays from the Puntledge to the Campbell in 1989 and 5 in 1990). A total of 699 CWT heads from adipose clipped fish recovered in the 1989 dead recovery were successfully decoded and 258 were decoded in 1990. Age 2 males (jacks) were included with all other adult males for this analysis.

The allocations of the total escapement of adipose clips to tag codes recovered in each portion of the river are shown in Tables 21, 22, 24 and 25. Table 23 lists the number of CWT fish and adipose clipped fish released for each tag code (data from MRP database). The estimated hatchery contributions to the 1989 escapement of chinook to the Campbell River, Quinsam River and Quinsam Hatchery were 1330, 5676, and 7231, respectively (Table 24). The estimated hatchery contributions to the 1990 escapement of chinook to the Campbell River, Quinsam River and Quinsam Hatchery were 1442, 4240, and 3287, respectively (Table 25).

The hatchery contributions to the total escapement of chinook each year, by age class is presented in Table 26 and Table 27. The hatchery contribution to the Campbell River population of chinook was estimated to be 69.9% for males and 53.9% for females in 1989. Contributions to the in-river Quinsam chinook escapement were 82.8% for males and 91.4% for females. This increased to 95.4% for males and 100.0% for females in the returns to the hatchery. The 1990 hatchery contribution to the Campbell River was 28.0% for males and 55.4% for females. Contributions to the in-river Quinsam chinook escapement were 57.7% for males and 67.8% for females. The contributions to the hatchery in 1990 were 62.6% for males and 58.4% for females. Strays from the Puntledge River contributed as much as 0.4% of the total CWT returns to the Campbell River in 1989 and 0.8% in 1990.

The hatchery contribution to the escapement in each of the river strata (Campbell River, Quinsam River and Quinsam Hatchery) was significantly higher in 1989 than in 1990 (χ^2, $P < 0.001$).

Hatchery Contributions - Method B

The allocations of the total escapement of CWTs to tag codes recovered in each portion of the river are shown in Tables 28 - 33. The estimated hatchery contributions to the 1989 escapement of chinook to the Campbell River, Quinsam River and Quinsam Hatchery using Method B were 1148, 5486, and 6185, respectively (Table 32). The estimated hatchery contributions to the 1990 escapement of chinook to the Campbell River, Quinsam River and Quinsam Hatchery were 1388, 3741, and 3089, respectively (Table 33).

The hatchery contribution to the total escapement of chinook each year, by age class is presented in Table 34 and Table 35. The 1989 hatchery contribution to the Campbell River population of chinook was estimated to be 61.2% for males and 45.8% for females. Contributions to the in-river Quinsam chinook escapement were 81.4% for males and 87.0% for females. These were similar to the 81.4% for males and 88.8% for females in the returns to the hatchery. The 1990 hatchery contribution to the Campbell River was 28.0% for males and 52.2% for females. Contributions to the in-river Quinsam chinook escapement were 48.4% for males and 62.2% for females. The contributions to the hatchery in 1990 were 62.5% for males and 50.3% for females. Strays contributed as much as 0.4% of the total CWT returns to the Campbell River in 1989 and 0.8% in 1990.

DISCUSSION AND CONCLUSIONS

POPULATION ESTIMATION

Several potentially important sources of bias in Petersen estimates were circumvented by stratifying the populations of each river by sex. In this study, there were factors that affected sexes differentially, as indicated by differences in the sex ratios obtained in hatchery seining for broodstock, dead recovery, and Petersen estimates. A higher proportion of females were recovered in the dead pitch surveys each year than males. Andrew et al. (1988) found similar differences in the sex ratios between dead pitch recoveries in both rivers in 1986, as did Shardlow (1986) in 1984-85. Higher proportions of females than males have also been observed in spawning ground dead pitches for sockeye (Petersen 1954), pinks (Ward 1959), and coho (Eames and Hino 1981, and Eames et al. 1981). Hence, it is important to continue to stratify escapement estimates on the Quinsam/Campbell by sex.

Potentially important sources of bias in Petersen estimates were also circumvented by stratifying the estimates by river. Results indicated that there was very little straying between major river strata or between tagging and recovery strata within each river. There was also no significant difference between the tag recovery rates in the Campbell and Quinsam rivers.

A high degree of straying between rivers by live-tagged fish was circumvented by the use of tagged carcasses. However, one factor which could have produced a serious bias in the carcass tagging Petersen estimate is the incomplete mixing of tagged carcasses with the rest of the carcass population, particularly in deep pools, where many carcasses may have been immobilized. Biases due to incomplete mixing was reduced by conducting tagging and recovery effort in proportion to the distribution of fish.

Errors in the raw data (most notably in the number of carcasses examined, see Appendices A6, A7, B5, B6) may have caused an over-or under-estimation of the escapements. For example, on 'some days, crews recorded that they observed fewer carcasses than the sum of the number of tags recovered and the number of tags applied. The sum of these two numbers should always be less than

or equal to the total number of carcasses examined. This type of error, if significant, could lead to an underestimate of the total number of carcasses examined, and hence an underestimate of the population.

The confidence intervals for the carcass tagging population estimates were within 7% of the estimate in 1989 and 18% of the estimate in 1990. the difference in confidence for each estimate can be attributed to the lower tag recovery rate in 1990 caused by extensive flooding.

The Petersen population estimates obtained from live tagging in 1989 are unreliable because of the extreme low recovery rates. Predation by seals at the time of release is believed to have caused high mortalities in tagged fish as seals were frequently sighted during tagging.

AGE, LENGTH AND SEX COMPOSITION

The Campbell and Quinsam rivers chinook escapements are composed mainly of age 4 and 5 fish. The ratio of males to females, as determined from the Petersen estimates, in the Campbell River changed from 0.77 in 1989 to 0.97 in 1990. Similarly, the ratio of males to females in the Quinsam River increased from 0.99 in 1989 to 0.75 in 1990. The sex ratio of hatchery returns fluctuated from 1.49 in 1989 to 1.24 in 1990.

CODED WIRE TAGGING AND RECOVERY

In this study, we used the adipose clip rate in the dead recovery of chinook in the rivers and at the hatchery rack to estimate the number of adipose clips in the escapement (Method A). Sampling for adipose clipped fish was random at each of these locations. The mark rate of recovery was higher in 1989 (5.4% - 8.5%) than in 1990 (3.5% - 4.3%).

Estimates of the total hatchery contribution to the Quinsam Campbell River system were different using Method A (AFC rate) and Method B (CWT rate). Method A produced higher hatchery contribution estimates (53.9% to 100.0% in 1989 and 28.0% to 67.8% in 1990) than Method B (45.8% to 88.8% in 1989 and 28.0% to 62.5% in 1990). The biggest difference between results for the two methods was in 1989. Bocking (1991) discusses potential reasons for similar differences observed at Stamp River.

Although we have tried to address as many potential sources of bias as possible in the estimation of the escapement of CWTs described above, we have not explicitly included the following factors:

1. The low number of recoveries of adipose clips and decoded CWTs (less than 20 CWTs in some brood years) may make the precision of the estimates so low as to be of relatively little use in those brood years; and

2. The sample of heads obtained for the decoding of CWTs may not be a random sample from the population and might contain a bias due to size selectivity or other factors.

We have not formally estimated the level of precision of the estimates of escapement by adipose clipped fish and individual tag codes as potential sources of bias can render these misleading. An approximation of the level of precision can be obtained by examining the number of adipose clips/CWT recoveries on which a given estimate is based. There were 65 to 375 adipose clips enumerated for each sex (jacks and males pooled). The 95% confidence limits for 65 recoveries (based on a Poisson frequency distribution) would be approximately $\pm$ 25% and significantly smaller for 375 recoveries. These estimates of precision are conservative because the expansion factors used to estimate the total number of adipose clips/marks in the escapement are also estimated with error.

There was a substantial drop in the total contribution of hatchery chinook (sum of all river and sex strata) to the Quinsam River system escapement from 1989 (96.0%) to 1990 (57.7%) (Method A). This was likely due to very poor smolt to adult survival of the 1985 brood year which also explains the low number of age 5 returns in 1990 (Jim Van Tine, pers. comm.). There were also differences between the hatchery contribution to each of the Campbell River, the Quinsam River, and the Quinsam Hatchery within each year. In general, there was a higher proportion of hatchery reared fish in the Quinsam River and Hatchery than in the Campbell River. This pattern has been observed in previous years (Bocking et al. 1990).

SUMMARY

1. Total escapement estimates for chinook salmon in the Campbell/Quinsam rivers system using carcass tagging were 14825 in 1989 and 15538 in 1990. These estimates were stratified by river and sex.

2. Population estimates based on live tagging in 1989 were almost double the carcass tagging estimate and were considered unreliable because of heavy predation on tagged chinook in the estuary by seals.

3. The age composition of chinook varied between the Campbell and Quinsam rivers and the Quinsam Hatchery as well as between years. Male chinook were predominantly age 4 or 5 while females were predominantly age 5. In 1989, there was a large proportion of age 3 male returns to the hatchery. The overall age at return was lower in 1990 than in 1989.

4. Females were more abundant in the river populations while males were generally more abundant in the hatchery returns.

5. The mean length of chinook salmon was greatest in the Campbell River, and smallest in the Quinsam Hatchery returns. Females tended to be significantly larger than males.

6. The total estimated return of adipose clipped chinook to the Campbell/Quinsam rivers system was 1112 in 1989, and 612 in 1990.

7. The total estimated hatchery contribution to the chinook escapement, based on adipose clips (Method A) was 14237 (96.0%) in 1989 and 8969 (57.7%) in 1990. The contribution estimates derived using the adjusted CWTs recovered (Method B) were lower: 11797 (79.6%) in 1989 and 8218 (52.9%) in 1990.

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Table 1. Summary of methods for the Campbell and Quinsam rivers chinook salmon enumeration programs, 1989-90.

Item	Method and Materials	
	1989	1990
Dead recovery population estimate	Petersen estimate, sum of separate estimates for sexes and rivers	Petersen estimate, sum of separate estimates for sexes and rivers
Live tagging population estimate	Petersen estimate, sum of separate estimates for sexes	None
Dead tagging	Cattle ear tags (a) applied in situ to carcasses recovered in river	Cattle ear tags applied in situ to carcasses recovered in river
Live tagging	Cattle ear tags applied to live chinook captured in estuary	None
Secondary marking (dead)	Two hole opercular punch for Campbell and single hole punch for Quinsam on left operculum	Two hole opercular punch for Campbell and single hole punch for Quinsam on left operculum
Secondary marking (live)	Single hole opercular punch on right side	None
Recovery of fish	Foot, SCUBA surveys, rack	Foot, SCUBA surveys, rack
Coded wire tagging (CWT)	Collection of heads from adipose clipped fish in dead recovery and at hatchery rack	Collection of heads from adipose clipped fish in dead recovery and at hatchery rack
Biological and physical sampling	Ages from scales and CWT Sex ratios from sex specific population estimates for each river and at hatchery rack Postorbital-hypural length	Ages from scales and CWT Sex ratios from sex specific population estimates for each river and at hatchery rack Postorbital-hypural length

(a) Tags were supplied by Ketchum Manufacturing Sales Ltd., 396 Berkely Ave., Ottawa, Ontario, Canada, K2A 2G6. The tags used (Size No. 3, 1 1/8 " x 1/4") are recommended for sheep and swine.

Table 2. Summary of recovery effort (number of person days) for chinook salmon carcasses in Campbell and Quinsam rivers, 1989.

River	Number of person days
Campbell	70
Quinsam	96

Table 3. Summary of recovery effort (number of person days) for chinook salmon carcasses in Campbell and Quinsam rivers, 1990.

River	Number of person days
Campbell	40
Quinsam	76

Table 4. Summary of in situ carcass tagging and dead recovery of chinook salmon in Campbell and Quinsam rivers, 1989.

Category	Campbell (a)	Quinsam (b)	Total
Carcass tagging:			
Males	131	660	791
Females	259	1106	1365
Jacks	1	6	7
Total	391	1772	2163
Dead recovery:			
Males	343	1860	2203
Females	499	2272	2771
Jacks	2	44	46
Total	844	4176	5020
Tagged males (c)	54	405	459
Tagged females	117	749	866
Tagged jacks	0	0	0
Total tagged	171	1154	1325
Tag rate (%)	20.3	27.6	26.4
Tag recovery rate (%)	43.7	65.1	61.3
Tag loss (%)	2.9	1.7	2.3

(a) See Appendix A6 for number of carcasses examined, number of carcasses tagged, and number of tag recoveries by date

(a) See Appendix A7 for number of carcasses examined, number of carcasses tagged, and number of tag recoveries by date

(c) Tagged recoveries include all carcasses with opercular punch holes (i.e. secondary marks)

Table 5. Summary of in situ carcass tagging and dead recovery of chinook salmon in Campbell and Quinsam rivers, 1990.

Category	Campbell (a)	Quinsam (b)	Total
Carcass tagging:			
Males	117	233	350
Females	151	348	499
Jacks	3	1	4
Total	271	582	853
Dead recovery:			
Males	320	1237	1557
Females	333	1836	2169
Jacks	11	24	35
Total	664	3097	3761
Tagged males (c)	29	86	115
Tagged females	34	152	186
Tagged jacks	0	0	0
Total tagged	63	238	301
Tag rate (%)	9.5	7.7	8.0
Tag recovery rate (%)	23.2	40.9	35.3
Tag loss (%)	3.2	3.8	3.5

(a) See Appendix B5 for number of carcasses examined, number of carcasses tagged, and number of tag recoveries by date

(a) See Appendix B6 for number of carcasses examined, number of carcasses tagged, and number of tag recoveries by date

(c) Tagged recoveries include all carcasses with opercular punch holes (i.e. secondary marks)

Table 6. Petersen population estimates, confidence limits and enumeration data for chinook salmon escapement in the Campbell River, Quinsam River, and Quinsam Hatchery based on in situ chinook carcass tagging and recovery of carcasses, 1989. Confidence limits are from fudicial limits for the Poisson distribution using Pearson's formulae when R is greater than 50 (Ricker 1975, p. 343).

River and Item	Male	Female	Jack	Total
Campbell River				
Number tagged	131	259	1	391
Number recovered	343	499	2	844
Number of tagged fish recovered (a)	54	117	0	171
Number of tagged strays from Quinsam River	8	14	0	22
Expanded No. of tagged strays from Quinsam River	19	31	0	50
Number of tagged fish for Petersen estimate	150	290	1	441
Petersen estimate	947	1233	6	2186
Lower 95% CL	739	1038	1	1778
Upper 95% CL	1259	1490	6	2755
Quinsam River (below fence)				
Number tagged	660	1106	6	1772
Number recovered	1860	2272	44	4176
Number of tagged fish recovered (a)	405	749	0	1154
Number of tagged strays from Campbell River	0	0	0	0
Expanded No. of tagged strays from Campbell River	0	0	0	0
Number of tagged fish for Petersen estimate	641	1075	6	1722
Petersen estimate	2941	3261	315	6517
Lower 95% CL	2675	3040	67	5781
Upper 95% CL	3250	3508	315	7072
Quinsam River (above fence)				
Number of fish (b,c)	598	634	21	1253
Quinsam Hatchery (d)				
Number of fish (b)	2986	1799	84	4869
Total system				
Escapement estimate	7472	6927	426	14825
Upper 95% CL	6400	5876	152	12429
Lower 95% CL	7494	6797	405	14696

(a) Includes all fish with secondary marks (i.e. opercular punch holes)
(b) Confidence limits not applicable
(c) Estimate for Quinsam River, above the fence, includes 771unknowns apportioned to adult males and females using the ratio of observed males to females in the Quinsam dead pitch
(d) rack recoveries

Table 7. Petersen population estimates, confidence limits and enumeration data for chinook salmon escapement in the Campbell River, Quinsam River, and Quinsam Hatchery based on in situ chinook carcass tagging and recovery of carcasses, 1990. Confidence limits are from fudicial limits for the Poisson distribution using Pearson's formulae when R is greater than 50 (Ricker 1975, p. 343).

River and Item	Male	Female	Jack	Total
Campbell River				
Number tagged	117	151	3	271
Number recovered	320	333	11	664
Number of tagged fish recovered (a)	29	34	0	63
Number of tagged strays from Quinsam River	9	7	0	16
Expanded No. of tagged strays from Quinsam River	36	31	0	67
Number of tagged fish for Petersen estimate	153	182	3	338
Petersen estimate	1651	1747	48	3446
Lower 95% CL	1163	1261	10	2434
Upper 95% CL	2428	2496	48	4972
QuinsamRiver				
Number tagged	233	348	1	582
Number recovered	1237	1836	24	3097
Number of tagged fish recovered (a)	86	152	0	238
Number of tagged strays from Campbell River	0	0	0	0
Expanded No. of tagged strays from Campbell River	0	0	0	0
Number of tagged fish for Petersen estimate	197	317	1	515
Petersen estimate	2813	3817	50	6680
Lower 95% CL	2304	3278	11	5593
Upper 95% CL	3514	4504	50	8068
Quinsam Hatchery (d)				
Number of fish (b,c)	2939	2413	60	5412
Total system				
Escapement estimate	7403	7977	158	15538
Upper 95% CL	6406	6952	81	13439
Lower 95% CL	8882	9413	158	18452

(a) Includes all fish with secondary marks (opercular punch holes)
(b) Confidence limits not applicable
(c) Estimate for hatchery includes 1735 unknowns apportioned to adult males and females using the ratio of observed males to females in the known hatchery returns.
(d) includes both rack recoveries and escapement to Quinsam River above the fence

Table 8. Summary of live tagging and recovery of chinook salmon in Campbell and Quinsam rivers and Quinsam Hatchery and Petersen estimates of escapement using three different sources of recovery information, 1989. confidence limits are from fudicial limits for the Poisson distribution using Pearson's formulae when R is greater than 50 (Ricker 1975, p. 343). The data did not permit a population estimate for jacks.

Item	Males	Females	Jacks	Total
Number tagged in estuary (live)	226	239	28	493
A. Quinsam Hatchery live recovery at rack				
Number examined for tags (a)	2986	1799	84	4869
Number of tagged fish recovered (b)	62	29	1	92
Number of tags recovered in estuary	0	11	0	11
No. of tags applied	226	228	28	482
Petersen estimate	10763	13740	1233	25735
Upper 95% CL	14020	9676	2241	25937
Lower 95% CL	8531	5270	373	14175
B. Campbell and Quinsam rivers dead recovery				
Number examined for tags (a)	2235	2785	46	5066
Number of tagged fish recovered (b)	30	31	0	61
No. of tags applied	226	228	28	482
Petersen estimate	16373	19937	1363	37674
Upper 95% CL	23942	27982	1363	51924
Lower 95% CL	11588	13839	290	25428
C. Quinsam Hatchery live recovery and both rivers dead recovery combined (c)				
Number examined for tags (a)	5221	4584	130	9805
Number of tagged fish recovered (b)	92	60	1	152
No. of tags applied	226	228	28	454
Petersen estimate	12746	17213	1900	29959
Upper 95% CL	15801	22526	25644	38327
Lower 95% CL	4604	4045	94	8649
Tag rate for live plus dead recovery (%):	1.8	1.3	0.8	2
Tag recovery rate for live plus dead recovery (%):	40.7	25.1	3.6	33
Tag loss(%):	3.3	3.3	0.0	2

(a) From Appendix A6 and A7

(b) Includes all fish with secondary marks (i.e. opercular hole punches) captured after last day of tagging, stratified by sex. The tag recoveries are only for live-tagging releases.

(c) Does not include recoveries above the Quinsam River fence

Table 9. Age composition of Campbell River chinook salmon, 1989 (Determined from dead recovery).

Sex and age	Unmarked	AD/CWT	Total	Percent	Postorbital-hypural length (mm) N	Mean		SD	95% CL Lower	95% CL Upper
Males (a)										
3.1	11	2	13	8.9	13	582		59	546	618
4.1	30	4	34	23.3	34	753		58	734	772
5.1	83	15	98	67.1	98	855		57	844	866
6.1	1	0	1	0.7	1	920		0	920	920
Total aged	125	21	146	100.0	146	807	(b)	57	798	817
Unknown age			42		42	812		90	785	839
Total			188							
Females										
4.1	9	4	13	6.5	13	751		71	708	794
5.1	152	30	182	91.5	183	842		43	836	848
5.2	1	0	1	0.5						
6.1	3	0	3	1.5	3	922		48	803	1041
Total aged	165	34	199	100.0	199	837	(b)	45	831	844
Unknown age			132		132	833		46	825	841
Total			331							

(a) Includes jacks
(b) Weighted mean and standard deviation

Table 10. Age composition of Quinsam River chinook salmon, 1989 (Determined from dead recovery).

Sex and age	Unmarked	AD/CWT	Total	Percent	Postorbital-hypural length (mm) N	Mean		SD	95% CL Lower	95% CL Upper
Males (a)										
3.1	60	26	86	29.2	86	600		51	589	611
4.1	33	25	58	19.7	58	737		42	726	748
5.1	71	80	151	51.2	151	826		57	817	835
Total aged	164	131	295	100.0	295	743	(b)	53	737	749
Unknown age			181		181	755		115	738	772
Total			476							
Females										
4.1	29	17	46	12.2	46	760		50	746	774
5.1	144	184	328	87.0						
5.2	1	0	1	0.3	329	821		48	816	826
6.1	1	1	2	0.5	2	835		21	646	1024
Total aged	175	202	377	100.0	377	814	(b)	48	809	818
Unknown age			468		468	813		48	809	817
Total			845							

(a) Includes jacks
(b) Weighted mean and standard deviation

Table 11. Age composition of Quinsam Hatchery chinook salmon, 1989 (Determined from rack recovery).

Sex and age	Unmarked	AD/CWT	Total	Percent	Postorbital-hypural length (mm)					
					N	Mean		SD	95% CL Lower	95% CL Upper
Males (a)										
2.1	0	2	2	0.6	2	376		21	187	565
3.1	61	96	157	44.7	147	609		55	600	618
4.1	56	29	85	24.2	84	747		50	736	758
5.1	65	40	105	29.9	107	818		51	808	828
5.2	2	0	2	0.6						
Total aged	184	167	351	100.0	338	712	(b)	53	706	717
Unknown age			117		117	709		118	688	730
Total			468							
Females										
3.1	8	4	12	2.8	12	653		53	619	687
4.1	53	4	57	13.4	57	746		40	736	756
5.1	213	140	353	83.1	354	816		45	811	821
5.2	2	0	2	0.5						
6.1	1	0	1	0.2	1	887		0	887	887
Total aged	277	148	425	100.0	423	804	(b)	45	800	808
Unknown age			83		83	790		63	776	804
Total			508							

(a) Includes jacks
(b) Weighted mean and standard deviation

Table 12. Age composition of Campbell River chinook salmon, 1990 (Determined from dead recovery).

Sex and age	Unmarked	AD/CWT	Total	Percent	Postorbital-hypural length (mm)					
					N	Mean		SD	95% CL	
									Lower	Upper
Males (a)										
3.1	6	0	6	4.2	6	582		37	543	621
4.1	70	3	73	51.4	73	758		61	744	772
5.1	53	4	57	40.1	57	870		48	858	882
6.1	5	1	6	4.2	6	898		41	855	941
Total aged	134	8	142	100.0	142	801	(b)	54	792	810
Unknown age			19		19	833		71	799	867
Total			161							
Females										
3.1	1	0	1	0.5	1	670		0	670	670
4.1	50	4	54	27.7	54	755		47	742	768
5.1	100	11	111	56.9	111	845		42	837	853
6.1	27	2	29	14.9	29	910		52	891	929
Total aged	178	17	195	100.0	195	829	(b)	45	823	835
Unknown age			17		17	834		64	801	867
Total			212							

(a) Includes jacks
(b) Weighted mean and standard deviation

Table 13. Age composition of Quinsam River chinook salmon, 1990 (Determined from dead recovery).

Sex and age	Unmarked	AD/CWT	Total	Percent	Postorbital-hypural length (mm) N	Mean		SD	95% CL Lower	95% CL Upper
Males (a)										
2.1	0	2	2	1.2						
3.1	2	5	7	4.3	9	619		53	578	660
4.1	80	23	103	64.0	103	749		53	739	759
5.1	36	10	46	28.7	47	840		62	822	858
5.2	1	0	1	0.6						
6.1	1	1	2	1.2	2	870		14	744	996
Total aged	120	41	161	100.0	159	779	(b)	56	771	788
Unknown age			22		22	773		98	729	817
Total			183							
Females										
4.1	106	30	136	50.4	136	747		44	740	754
5.1	77	38	115	42.6	115	823		51	814	832
6.1	10	9	19	7.0	19	873		47	850	896
Total aged	193	77	270	100.0	270	788	(b)	47	783	794
Unknown age			161		161	787		61	778	796
Total			431							

(a) Includes jacks

(b) Weighted mean and standard deviation

Table 14. Age composition of Quinsam Hatchery chinook salmon, 1990 (Determined from rack recovery).

Sex and age	Unmarked	AD/CWT	Total	Percent	Postorbital-hypural length (mm)				
					N	Mean		SD	95% CL
									Lower Upper
Males (a)									
2.1	0	3	3	1.1	3	395		25	333 457
3.1	14	12	26	10.0	26	590		38	574 606
4.1	167	59	226	86.6	226	723		50	716 730
5.1	6	0	6	2.3	6	822		48	771 873
Total aged	187	74	261	100.0	261	708	(b)	49	702 714
Unknown age			85		85	709		54	698 720
Total			346						
Females									
3.1	1	0	1	0.3	1	570		0	570 570
4.1	264	37	301	88.5	301	743		43	738 748
5.1	24	11	35	10.3	35	820		44	805 835
6.1	2	1	3	0.9	3	836		21	784 888
Total aged	291	49	340	100.0	340	751	(b)	43	747 756
Unknown age			40		40	760		53	743 777
Total			380						

(a) Includes jacks
(b) Weighted mean and standard deviation

Table 15. Age-length distribution of Campbell River, Quinsam River and Quinsam Hatchery chinook salmon, 1989.

River	Length class (mm)	Age													
		Males (a)							Females						
		2	3	4	5	6	Total	Unk(b)	2	3	4	5	6	Total	Unk
Campbell River															
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	400-449	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	500-549	0	2	0	0	0	2	0	0	0	0	0	0	0	0
	550-599	0	5	0	0	0	5	0	0	0	0	0	0	0	0
	600-649	0	3	1	0	0	4	4	0	0	1	0	0	1	0
	650-699	0	2	1	1	0	4	0	0	0	1	0	0	1	0
	700-749	0	1	10	2	0	13	3	0	0	2	0	0	2	2
	750-799	0	0	7	3	0	10	3	0	0	4	8	0	12	9
	800-849	0	0	11	22	0	33	11	0	0	3	58	0	61	52
	850-899	0	0	4	35	0	39	12	0	0	2	79	1	82	45
	900-949	0	0	0	25	1	25	7	0	0	0	33	0	33	20
	950-999	0	0	0	8	0	8	2	0	0	0	5	2	7	3
	1000-1049	0	0	0	2	0	2	0	0	0	0	0	0	0	1
	Mean	0	582	753	855	920	807 (c)	812	0	0	751	842	922	837 (c)	833
	SD	0	59	58	57	0	57	90	0	0	71	43	48	47	46
	N	0	13	34	98	1	145	42	0	0	13	183	3	199	132
Quinsam River															
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	400-449	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	500-549	0	4	0	0	0	4	5	0	0	0	0	0	0	0
	550-599	0	26	0	0	0	26	11	0	0	0	0	0	0	0
	600-649	0	30	1	0	0	31	20	0	0	0	0	0	0	0
	650-699	0	22	2	1	0	25	13	0	0	2	0	0	2	2
	700-749	0	3	20	7	0	30	14	0	0	7	12	0	19	28
	750-799	0	1	25	20	0	46	20	0	0	17	34	0	51	62
	800-849	0	0	10	45	0	55	40	0	0	18	128	1	147	179
	850-899	0	0	0	50	0	50	32	0	0	1	113	1	115	161
	900-949	0	0	0	24	0	24	23	0	0	1	38	0	39	34
	950-999	0	0	0	4	0	4	3	0	0	0	4	0	4	2
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	0	600	737	826	0	743 (c)	755	0	0	760	821	835	814 (c)	813
	SD	0	51	42	57	0	53	115	0	0	50	48	21	48	48
	N	0	86	58	151	0	295	181	0	0	46	329	2	377	468

Table 15. Age-length distribution of Campbell River, Quinsam River and Quinsam Hatchery chinook salmon, 1989.

River	Length class (mm)	Age													
		Males (a)							Females						
		2	3	4	5	6	Total	Unk(b)	2	3	4	5	6	Total	Unk
Quinsam Hatchery															
	250-299	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	400-449	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	3	0	0	0	0	0	0	0
	500-549	0	7	0	0	0	7	3	0	0	0	0	0	0	0
	550-599	0	33	0	0	0	33	2	0	0	0	0	0	0	1
	600-649	0	54	1	0	0	55	20	0	5	0	0	0	5	0
	650-699	0	33	6	0	0	39	16	0	2	3	0	0	5	3
	700-749	0	18	20	4	0	42	15	0	4	12	12	0	28	5
	750-799	0	2	30	16	0	48	18	0	1	27	50	0	78	20
	800-849	0	0	24	41	0	65	20	0	0	14	137	0	151	27
	850-899	0	0	3	30	0	33	13	0	0	1	124	0	125	24
	900-949	0	0	0	16	0	16	5	0	0	0	29	1	29	2
	950-999	0	0	0	0	0	0	1	0	0	0	2	0	2	1
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	376	609	747	818	0	712 (c)	709	0	653	746	816	887	804 (c)	790
	SD	21	55	50	51	0	53	118	0	53	40	45	0	45	63
	N	2	147	84	107	0	340	117	0	12	57	354	1	423	83

(a) Includes jacks
(b) Unk = age unknown
(c) Weighted mean and standard deviation

Table 16. Age-length distribution of Campbell River, Quinsam River and Quinsam Hatchery chinook salmon, 1990.

River	Length class (mm)	Age													
		Males (a)							Females						
		2	3	4	5	6	Total	Unk(b)	2	3	4	5	6	Total	Unk
Campbell River															
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	400-449	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	500-549	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	550-599	0	4	0	0	0	4	0	0	0	0	0	0	0	0
	600-649	0	1	2	0	0	3	0	0	0	0	0	0	0	0
	650-699	0	1	5	0	0	6	0	0	1	2	0	0	3	0
	700-749	0	0	12	0	0	12	1	0	0	7	1	0	8	1
	750-799	0	0	23	2	0	25	4	0	0	30	5	1	36	1
	800-849	0	0	23	7	0	30	3	0	0	11	24	0	35	7
	850-899	0	0	7	22	2	31	5	0	0	3	53	4	60	3
	900-949	0	0	1	18	2	21	4	0	0	1	27	12	40	4
	950-999	0	0	0	8	2	10	2	0	0	0	1	10	11	1
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	2	2	0
	Mean	0	582	758	870	898	801(c)	833	0	670	755	845	910	829(c)	834
	SD	0	37	61	48	41	54.5	71	0	0	47	42	52	44.9	64
	N	0	6	73	57	6	142	19	0	1	54	111	29	195	17
Quinsam River															
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	400-449	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	500-549	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	550-599	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	600-649	0	5	0	0	0	5	2	0	0	1	0	0	1	0
	650-699	0	2	6	1	0	9	1	0	0	6	0	0	6	4
	700-749	0	1	32	1	0	34	3	0	0	36	5	0	41	21
	750-799	0	0	36	7	0	43	6	0	0	58	15	0	73	46
	800-849	0	0	18	7	0	25	2	0	0	31	39	3	73	45
	850-899	0	0	10	18	1	29	4	0	0	4	38	7	49	32
	900-949	0	0	1	11	1	13	2	0	0	0	16	7	23	11
	950-999	0	0	0	2	0	2	2	0	0	0	2	2	4	1
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Mean	0	619	749	840	870	779(c)	773	0	0	747	823	873	788(c)	787
	SD	0	53	53	62	14	55.5	98	0	0	44	51	47	47.3	61
	N	0	9	103	47	2	161	22	0	0	136	115	19	270	161

Table 16. Age-length distribution of Campbell River, Quinsam River and Quinsam Hatchery chinook salmon, 1990.

River	Length class (mm)	Age													
		Males (a)							Females						
		2	3	4	5	6	Total	Unk(b)	2	3	4	5	6	Total	Unk
Quinsam Hatchery															
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	400-449	2	0	0	0	0	2	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	500-549	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	550-599	0	11	0	0	0	11	1	0	1	1	0	0	2	0
	600-649	0	8	5	0	0	13	4	0	0	2	0	0	2	0
	650-699	0	6	34	0	0	40	6	0	0	14	0	0	14	2
	700-749	0	0	82	0	0	82	36	0	0	77	0	0	77	8
	750-799	0	0	71	0	0	71	26	0	0	136	7	0	143	15
	800-849	0	0	27	4	0	31	11	0	0	65	9	1	75	10
	850-899	0	0	7	1	0	8	1	0	0	5	15	2	22	5
	900-949	0	0	0	1	0	1	0	0	0	1	4	0	5	0
	950-999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	395	590	723	822	0	708(c)	722	0	570	743	820	836	751(c)	760
	SD	25	38	50	48	0	48.6	54	0	0	43	44	21	42.9	53
	N	3	26	226	6	0	261	85	0	1	301	35	3	340	40

(a) Includes jacks
(b) Unk = age unknown
(c) Weighted mean and standard deviaition

Table 17. Petersen estimates, by age, of chinook salmon escapement to the Campbell River, Quinsam River, and Quinsam Hatchery, 1989.

River	Age	Males (a)		Females	
		Number	Percent	Number	Percent
Campbell River					
	3.1	85	8.9	0	0.0
	4.1	222	23.3	80	6.5
	5.1	639	67.1	1129	91.5
	5.2	0	0.0	6	0.5
	6.1	7	0.7	18	1.5
	Total	953	100.0	1233	100.0
Quinsam River					
	3.1	947	29.1	0	0.0
	4.1	641	19.7	398	12.2
	5.1	1668	51.2	2837	87.0
	5.2	0	0.0	10	0.3
	6.1	0	0.0	16	0.5
	Total	3256	100.0	3261	100.0
Quinsam Hatchery (b)					
	2.1	22	0.6	0	0.0
	3.1	1649	44.7	68	2.8
	4.1	893	24.2	326	13.4
	5.1	1103	29.9	2022	83.1
	5.2	22	0.6	12	0.5
	6.1	0	0.0	5	0.2
	Total	3689	100.0	2433	100.0

(a) Includes jacks

(b) Includes fish counted above fence on Quinsam River

Table 18. Petersen estimates, by age, of chinook salmon escapement to the Campbell River, Quinsam River, and Quinsam Hatchery, 1990.

River	Age	Males (a)		Females	
		Number	Percent	Number	Percent
Campbell River					
	3.1	71	4.2	9	0.5
	4.1	875	51.5	484	27.7
	5.1	682	40.1	994	56.9
	6.1	71	4.2	260	14.9
	Total	1699	100.0	1747	100.0
Quinsam River					
	2.1	34	1.2	0	0.0
	3.1	123	4.3	0	0.0
	4.1	1833	64.0	1924	50.4
	5.1	822	28.7	1626	42.6
	5.2	17	0.6	0	0.0
	6.1	34	1.2	267	7.0
	Total	2863	100.0	3817	100.0
Quinsam Hatchery (b)					
	2.1	33	1.1	0	0.0
	3.1	300	10.0	7	0.3
	4.1	2597	86.6	2135	88.5
	5.2	69	2.3	249	10.3
	6.1	0	0.0	22	0.9
	Total	2999	100.0	2413	100.0

(a) Includes jacks

(b) Includes fish passed above the Quinsam River fence

Table 19. Estimates of the total escapement of adipose clipped fish to the Campbell and Quinsam rivers, and to the Quinsam Hatchery, 1989. The Petersen estimates were derived using the in situ carcass tagging method (Method A). Chinook recovered or passed above the Quinsam River fence were treated as a separate strata and were not used for the CWT contribution estimates.

River and sex	Sample size (a) A	Observed Adipose clips (b) B	Mark rate (%) C=(B/A)x10	Petersen population estimate (c) D	Percentage of population sampled E=(A/D)x100	Total estimated adipose clips F=(B/A)xD
Campbell River						
Male	356	25	7.0	947	37.6	67
Female	505	40	7.9	1233	41.0	98
Jack	2	0	0.0	6	33.3	0
Total	863	65	7.5	2186	39.5	164
Quinsam River (below fence)						
Male	1879	140	7.5	2941	63.9	219
Female	2280	217	9.5	3261	69.9	310
Jack	44	1	2.3	315	14.0	7
Total	4203	358	8.5	6517	64.5	537
Quinsam River (above fence) (d)						
Male	148	9	6.1	598	24.7	36
Female	161	8	5.0	634	25.4	32
Jack	8	0	0.0	21	38.1	0
Total	317	17	5.4	1253	25.3	68
Quinsam Hatchery						
Male	2986	173	5.8	2986	100.0	173
Female	1799	166	9.2	1799	100.0	166
Jack	84	4	4.8	84	100.0	4
Total	4869	343	7.0	4869	100.0	343

(a) From Appendix A5 and A6
(b) From Appendix A11and A12
(c) From Table 6
(d) The population estimate includes fish that swam through the fence and fish that were not examined for marks but were passed above the fence by hatchery staff. The number of fish examined for marks were observed during dead pitch surveys.

Table 20. Estimates of the total escapement of adipose clipped fish to the Campbell and Quinsam rivers, and to the Quinsam Hatchery, 1990. The Petersen estimates were derived using the in situ carcass tagging method (Method A).

River and sex	Sample size (a) A	Observed Adipose clips (b) B	Mark rate (%) C=(B/A)x10	Petersen population estimate (c) D	Percentage of population sampled E=(A/D)x100	Total estimated adipose clips F=(B/A)xD
Campbell River						
Male	328	8	2.4	1651	19.9	40
Female	335	18	5.4	1747	19.2	94
Jack	11	0	0.0	48	22.9	0
Total	674	26	3.9	3446	19.6	134
Quinsam River						
Male	1279	47	3.7	2813	45.5	103
Female	1870	87	4.7	3817	49.0	178
Jack	25	3	12.0	50	50.0	6
Total	3174	137	4.3	6680	47.5	287
Quinsam Hatchery (d)						
Male	1909	67	3.5	2939	65.0	103
Female	1500	52	3.5	2413	62.2	84
Jack	60	4	6.7	60	100.0	4
Total	3469	123	3.5	5412	64.1	191

(a) From Appendix B5 and B6
(b) From Appendix B7 and B8
(c) From Table 7
(d) Population estimates for Quinsam Hatchery include counts of fish at the rack and those fish passed upstream of the hatchery fence on the Quinsam River and not kept for broodstock

Table 21. Estimates of total escapement of adipose clipped chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated adipose clips for calculating the expanded hatchery contribution in Table 24 (Method A).

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1987	24419	0	0	0.0	0.0	1	0	1.8	0.0	0	0	0.0	0.0	1	0	1.8	0.0
	24956	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.3	0.0	1	0	1.3	0.0
	Subtotal	0	0	0.0	0.0	1	0	1.8	0.0	1	0	1.3	0.0	2	0	3.1	0.0
1986	24152	0	0	0.0	0.0	2	0	3.7	0.0	15	0	19.6	0.0	17	0	23.3	0.0
	24153	0	0	0.0	0.0	5	0	9.2	0.0	10	0	13.1	0.0	15	0	22.3	0.0
	24154	0	0	0.0	0.0	6	0	11.0	0.0	11	0	14.4	0.0	17	0	25.4	0.0
	24155	0	0	0.0	0.0	1	0	1.8	0.0	3	0	3.9	0.0	4	0	5.8	0.0
	24156	0	0	0.0	0.0	2	0	3.7	0.0	6	0	7.8	0.0	8	0	11.5	0.0
	24157	0	0	0.0	0.0	3	0	5.5	0.0	15	0	19.6	0.0	18	0	25.1	0.0
	24158	0	0	0.0	0.0	2	0	3.7	0.0	3	1	3.9	2.0	5	1	7.6	2.0
	24159	1	0	3.2	0.0	2	0	3.7	0.0	17	1	22.2	2.0	20	1	29.1	2.0
	24160	0	0	0.0	0.0	3	0	5.5	0.0	15	2	19.6	4.1	18	2	25.1	4.1
	Subtotal	1	0	3.2	0.0	26	0	47.8	0.0	95	4	124.1	8.1	122	4	175.1	8.1
1985	23522	0	0	0.0	0.0	1	0	1.8	0.0	2	1	2.6	2.0	3	1	4.5	2.0
	23523	0	0	0.0	0.0	1	1	1.8	1.6	2	0	2.6	0.0	3	1	4.5	1.6
	23524	0	0	0.0	0.0	3	1	5.5	1.6	2	0	2.6	0.0	5	1	8.1	1.6
	23525	0	1	0.0	2.9	3	0	5.5	0.0	4	1	5.2	2.0	7	2	10.7	4.9
	23554	0	0	0.0	0.0	2	3	3.7	4.8	5	0	6.5	0.0	7	3	10.2	4.8
	23555	0	0	0.0	0.0	3	1	5.5	1.6	1	1	1.3	2.0	4	2	6.8	3.6
	23556	1	0	3.2	0.0	4	0	7.3	0.0	1	0	1.3	0.0	6	0	11.8	0.0
	23557	0	0	0.0	0.0	2	1	3.7	1.6	7	0	9.1	0.0	9	1	12.8	1.6
	23558	1	0	3.2	0.0	4	6	7.3	9.5	5	1	6.5	2.0	10	7	17.1	11.6
	23645	0	2	0.0	5.8	1	4	1.8	6.4	1	0	1.3	0.0	2	6	3.1	12.1
	Subtotal	2	3	6.4	8.6	24	17	44.1	27.0	30	4	39.2	8.1	56	24	89.7	43.8

Table 21. Estimates of total escapement of adipose clipped chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated adipose clips for calculating the expanded hatchery contribution in Table 24 (Method A).

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1984	23322	1	2	3.2	5.8	1	3	1.8	4.8	4	9	5.2	18.2	6	14	10.3	28.8
	23323	0	1	0.0	2.9	4	11	7.3	17.5	3	12	3.9	24.3	7	24	11.3	44.7
	23324	1	4	3.2	11.5	6	6	11.0	9.5	2	8	2.6	16.2	9	18	16.8	37.3
	23325	0	1	0.0	2.9	5	20	9.2	31.8	2	18	2.6	36.5	7	39	11.8	71.1
	23326	2	2	6.4	5.8	5	16	9.2	25.4	3	19	3.9	38.5	10	37	19.5	69.7
	23327	3	0	9.6	0.0	5	13	9.2	20.7	8	18	10.5	36.5	16	31	29.2	57.1
	23328	1	1	3.2	2.9	11	20	20.2	31.8	10	15	13.1	30.4	22	36	36.5	65.1
	23329	2	2	6.4	5.8	6	16	11.0	25.4	4	15	5.2	30.4	12	33	22.6	61.6
	23330	2	1	6.4	2.9	4	15	7.3	23.8	4	13	5.2	26.3	10	29	19.0	53.1
	82351	0	0	0.0	0.0	0	6	0.0	9.5	2	4	2.6	8.1	2	10	2.6	17.6
	82352	0	1	0.0	2.9	2	7	3.7	11.1	1	1	1.3	2.0	3	9	5.0	16.0
	82353	0	2	0.0	5.8	9	7	16.5	11.1	2	1	2.6	2.0	11	10	19.1	18.9
	82354	0	1	0.0	2.9	2	3	3.7	4.8	0	1	0.0	2.0	2	5	3.7	9.7
	82355	2	3	6.4	8.6	2	4	3.7	6.4	0	0	0.0	0.0	4	7	10.1	15.0
	82356	0	2	0.0	5.8	3	6	5.5	9.5	0	3	0.0	6.1	3	11	5.5	21.4
	82357	0	1	0.0	2.9	2	7	3.7	11.1	0	2	0.0	4.1	2	10	3.7	18.1
	82358	0	0	0.0	0.0	1	4	1.8	6.4	1	1	1.3	2.0	2	5	3.1	8.4
	82359	1	2	3.2	5.8	3	8	5.5	12.7	0	1	0.0	2.0	4	11	8.7	20.5
	82360	0	1	0.0	2.9	1	0	1.8	0.0	1	1	1.3	2.0	2	2	3.1	4.9
	82361	0	0	0.0	0.0	0	3	0.0	4.8	0	0	0.0	0.0	0	3	0.0	4.8
	82362	0	3	0.0	8.6	0	2	0.0	3.2	0	3	0.0	6.1	0	8	0.0	17.9
	Subtotal	15	30	47.9	86.5	72	177	132.3	281.4	47	145	61.4	293.8	134	352	241.5	661.6
1983	82259	0	0	0.0	0.0	0	1	0.0	1.6	0	0	0.0	0.0	0	1	0.0	1.6
	Subtotal	0	0	0.0	0.0	0	1	0.0	1.6	0	0	0.0	0.0	0	1	0.0	1.6
Total hatchery		18	33	67	98	123	195	226	310	173	153	226	310	314	381	519	718

Table 21. Estimates of total escapement of adipose clipped chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated adipose clips for calculating the expanded hatchery contribution in Table 24 (Method A).

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Strays: (d)																	
1986	24704	1	0	3.2	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	3.2	0.0
1985	24030	1	0	3.2	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	3.2	0.0
1985	24104	1	1	3.2	2.9	0	0	0.0	0.0	0	0	0.0	0.0	1	1	3.2	2.9
Total strays		3	1	9.6	2.9	0	0	0.0	0.0	0	0	0.0	0.0	3	1	9.6	2.9
Total CWT		21	34	76.6	100.9	123	195	226.0	310.0	173	153	226.0	310.0	317	382	528.6	720.9
No data (5000)		1	0			0	0			2	2			3	2		
No pin (8000)		3	6			17	21			11	19			31	46		
Lost pin (9000)		0	0			1	1			0	0			1	1		
Observed adipose		25	40			141	217			186	174			352	431		

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) Includes adipose clips recovered at the rack and above the Quinsam River fence. See Appendix A13 for segregated CWT results.

(d) Adipose clipped fish that have strayed to this system from other enhancement facilities

Table 22. Estimates of total escapement of adipose clipped chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated adipose clips for calculating the expanded hatchery contribution in Table 25. (Method A)

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1987	24419	0	0	0.0	0.0	1	0	2.7	0.0	2	0	3.1	0.0	3	0	5.7	0.0
	24420	0	0	0.0	0.0	0	0	0.0	0.0	2	0	3.1	0.0	2	0	3.1	0.0
	24421	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.5	0.0	1	0	1.5	0.0
	24736	0	0	0.0	0.0	1	0	2.7	0.0	2	0	3.1	0.0	3	0	5.7	0.0
	24737	0	0	0.0	0.0	1	0	2.7	0.0	0	0	0.0	0.0	1	0	2.7	0.0
	25359	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.5	0.0	1	0	1.5	0.0
	25360	0	0	0.0	0.0	0	0	0.0	0.0	2	0	3.1	0.0	2	0	3.1	0.0
	25361	0	0	0.0	0.0	2	0	5.3	0.0	1	0	1.5	0.0	3	0	6.8	0.0
	25363	0	0	0.0	0.0	2	0	5.3	0.0	1	0	1.5	0.0	3	0	6.8	0.0
	Total	0	0	0.0	0.0	7	0	18.6	0.0	12	0	18.3	0.0	19	0	37.0	0.0
1986	24152	0	0	0.0	0.0	4	6	10.6	13.9	4	4	6.1	7.5	8	10	16.7	21.3
	24153	1	0	5.0	0.0	1	6	2.7	13.9	7	1	10.7	1.9	9	7	18.4	15.7
	24154	1	0	5.0	0.0	2	2	5.3	4.6	6	3	9.2	5.6	9	5	19.5	10.2
	24155	0	0	0.0	0.0	2	0	5.3	0.0	5	3	7.6	5.6	7	3	13.0	5.6
	24156	0	0	0.0	0.0	3	3	8.0	6.9	5	3	7.6	5.6	8	6	15.6	12.5
	24157	0	0	0.0	0.0	3	2	8.0	4.6	11	1	16.8	1.9	14	3	24.8	6.5
	24158	0	1	0.0	5.5	3	5	8.0	11.6	5	8	7.6	14.9	8	14	15.6	32.0
	24159	0	0	0.0	0.0	2	4	5.3	9.2	7	4	10.7	7.5	9	8	16.0	16.7
	24160	0	1	0.0	5.5	3	3	8.0	6.9	8	7	12.2	13.1	11	11	20.2	25.5
	Subtotal	2	2	10.0	11.1	23	31	61.1	71.7	58	34	88.7	63.5	83	67	159.8	146.2
1985	23522	0	0	0.0	0.0	0	2	0.0	4.6	0	0	0.0	0.0	0	2	0.0	4.6
	23523	0	0	0.0	0.0	1	0	2.7	0.0	0	3	0.0	5.6	1	3	2.7	5.6
	23524	2	1	10.0	5.5	1	4	2.7	9.2	0	0	0.0	0.0	3	5	12.7	14.8
	23525	0	0	0.0	0.0	0	2	0.0	4.6	0	0	0.0	0.0	0	2	0.0	4.6
	23554	0	1	0.0	5.5	0	4	0.0	9.2	0	2	0.0	3.7	0	7	0.0	18.5
	23555	0	2	0.0	11.1	1	5	2.7	11.6	0	0	0.0	0.0	1	7	2.7	22.6
	23556	1	1	5.0	5.5	1	6	2.7	13.9	0	0	0.0	0.0	2	7	7.7	19.4

Table 22. Estimates of total escapement of adipose clipped chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated adipose clips for calculating the expanded hatchery contribution in Table 25. (Method A)

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
	23557	0	0	0.0	0.0	1	3	2.7	6.9	0	1	0.0	1.9	1	4	2.7	8.8
	23558	1	2	5.0	11.1	3	7	8.0	16.2	0	2	0.0	3.7	4	11	13.0	31.0
	23645	0	2	0.0	11.1	2	4	5.3	9.2	0	1	0.0	1.9	2	7	5.3	22.2
	Subtotal	4	9	20.0	49.8	10	37	26.6	85.5	0	9	0.0	16.8	14	55	46.6	152.1
1984	23322	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	1.9	0	1	0.0	1.9
	23323	0	0	0.0	0.0	0	1	0.0	2.3	0	0	0.0	0.0	0	1	0.0	2.3
	23324	0	1	0.0	5.5	0	1	0.0	2.3	0	0	0.0	0.0	0	2	0.0	7.8
	23325	0	1	0.0	5.5	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	5.5
	23326	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	1.9	0	1	0.0	1.9
	23329	0	0	0.0	0.0	0	3	0.0	6.9	0	0	0.0	0.0	0	3	0.0	6.9
	23330	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0
	82352	0	0	0.0	0.0	0	3	0.0	6.9	0	0	0.0	0.0	0	3	0.0	6.9
	82354	1	0	5.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	5.0	0.0
	82355	0	0	0.0	0.0	0	1	0.0	2.3	0	0	0.0	0.0	0	1	0.0	2.3
	82356	0	0	0.0	0.0	1	0	2.7	0.0	0	0	0.0	0.0	1	0	2.7	0.0
	Subtotal	1	2	5.0	11.1	1	9	2.7	20.8	0	2	0.0	3.7	2	13	7.7	35.6
Total hatchery		7	13	40	94	41	77	109	178	70	45	107	84	118	135	256.0	356.0
Strays: (c)														0	0	0.0	0.0
1986	24703	0	1	0.0	5.5	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	5.5
1986	24704	1	1	5.0	5.5	0	0	0.0	0.0	0	0	0.0	0.0	1	1	5.0	5.5
1985	24104	0	2	0.0	11.1	0	0	0.0	0.0	0	0	0.0	0.0	0	2	0.0	11.1
Total strays		1	4	5.0	22.1	0	0	0.0	0.0	0	0	0.0	0.0	1	4	5.0	22.1
Total CWT		8	17	45	116.1	41	77	109	178	70	45	107	84	119	139	261	378.12

Table 22. Estimates of total escapement of adipose clipped chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated adipose clips for calculating the expanded hatchery contribution in Table 25. (Method A)

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips		Observed adipose clips		Estimated adipose clips	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
No data (5000)		0	0			0	0			0	0			0	0		
No pin (8000)		0	1			9	7			1	7			10	15		
Lost pin (9000)		0	0			0	3			0	0			0	3		
Observed adipose		8	18			50	87			71	52			129	157		

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) Adipose clipped fish that have strayed to the system from other enhancement facilities

Table 23. CWT release data for hatchery reared chinook salmon returning to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989-90.

Brood year	CWT release group	Release Numbers		CWT loss (%)	Days held	Adipose release status	
		CWT	Untagged			Clipped	Unclipped
1987	24419	24457	333484	1.9	unk	24931	333010
	24420	24386	332520	1.9	unk	24858	332048
	24421	24486	333883	1.9	unk	24960	333409
	24736	20607	65511	1.9	unk	21006	65112
	24737	20607	65511	1.9	unk	21006	65112
	24956	24641	330657	1.9	10	25118	330180
	25359	24727	310993	1.9	10	25206	310514
	25360	24834	312340	1.9	10	25315	311859
	25361	24504	328819	1.9	10	24979	328344
	25363	24222	51484	1.9	10	24691	51015
1986	24152	19947	276591	0.0	0	19947	276591
	24153	19935	276591	0.0	0	19935	276591
	24154	19990	276591	0.0	0	19990	276591
	24155	18978	467555	0.0	0	18978	467555
	24156	20006	467555	0.0	0	20006	467555
	24157	19982	467555	0.0	0	19982	467555
	24158	19980	299513	0.0	0	19980	299513
	24159	19899	299513	0.0	0	19899	299513
	24160	19979	299513	0.0	0	19979	299513
1985	23522	19964	318335	0.0	0	19964	318335
	23523	19975	320079	0.0	0	19975	320079
	23524	20127	321701	0.0	0	20127	321701
	23525	20038	273848	0.0	0	20038	273848
	23554	20110	274832	0.0	0	20110	274832
	23555	20096	274640	0.0	0	20096	274640
	23556	20145	284309	0.0	0	20145	284309
	23557	20110	283815	0.0	0	20110	283815
	23558	20096	283618	0.0	0	20096	283618
	23645	24843	98507	0.0	0	24843	98507
1984	23322	24584	316880	0.0	23	24584	316880
	23323	24538	316288	0.0	23	24538	316288
	23324	24527	316145	0.0	23	24527	316145
	23325	26157	305357	0.0	17	26157	305357
	23326	24937	291114	0.0	17	24937	291114
	23327	23714	276837	0.0	17	23714	276837
	23328	24471	314874	0.2	15	24520	314825
	23329	29676	369721	0.2	15	29735	369662
	23330	24459	314724	0.2	15	24508	314675
	82351	9657	508	5.0	15	10165	0
	82352	10317	543	5.0	15	10860	0
	82353	10039	528	5.0	15	10567	0
	82354	10228	595	5.5	10	10823	0
	82355	10073	586	5.5	10	10659	0

Table 23. CWT release data for hatchery reared chinook salmon returning to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989-90.

Brood year	CWT release group	Release Numbers		CWT loss (%)	Days held	Adipose release status	
		CWT	Untagged			Clipped	Unclipped
	82356	9940	579	5.5	10	10519	0
	82357	10332	471	4.4	5	10808	0
	82358	10132	461	4.4	5	10598	0
	82359	10009	455	4.3	5	10459	5
	82360	10577	310	2.8	5	10882	5
	82361	10342	303	2.8	5	10640	5
	82362	10281	302	2.9	5	10588	0
1983	82259	10834	806	6.9	1	11637	3
	Total hatchery	981495	11158250			992696	11147064
Strays: (a)							
1986	24703	26423	0	0.0	1	26423	0
1986	24704	24567	0	0.0	1	24567	0
1985	24104	49247	801	1.6	7	50048	0
1985	24030	24987	0	0.0	0	24987	0

(a) Strays were all from Puntledge hatchery

Table 24. Estimates of total escapement of hatchery reared chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The expansion factor is used to expand the estimated number of adipose clipped chinook in the escapement (from Table 21) to account for unclipped hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (adipose clipped + unclipped releases) / adipose clipped releases.

Brood year	CWT release group	Release Numbers (d)		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery (c)		Total	
		Clipped	Unclipped		M(b)	F	M	F	M	F	M	F
1987	24419	24931	333010	14.36	0.0	0.0	26.4	0.0	0.0	0.0	26.4	0.0
	24956	25118	330180	14.15	0.0	0.0	0.0	0.0	18.5	0.0	18.5	0.0
	Subtotal	50049	663190		0.0	0.0	26.4	0.0	18.5	0.0	44.9	0.0
1986	24152	19947	276591	14.87	0.0	0.0	54.6	0.0	291.3	0.0	345.9	0.0
	24153	19935	276591	14.87	0.0	0.0	136.7	0.0	194.3	0.0	331.0	0.0
	24154	19990	276591	14.84	0.0	0.0	163.6	0.0	213.2	0.0	376.8	0.0
	24155	18978	467555	25.64	0.0	0.0	47.1	0.0	100.5	0.0	147.6	0.0
	24156	20006	467555	24.37	0.0	0.0	89.6	0.0	191.0	0.0	280.6	0.0
	24157	19982	467555	24.40	0.0	0.0	134.5	0.0	478.1	0.0	612.6	0.0
	24158	19980	299513	15.99	0.0	0.0	58.8	0.0	62.7	32.4	121.4	32.4
	24159	19899	299513	16.05	51.2	0.0	59.0	0.0	356.5	32.5	466.7	32.5
	24160	19979	299513	15.99	0.0	0.0	88.1	0.0	313.4	64.8	401.5	64.8
	Subtotal	178696	3130977		51.2	0.0	831.9	0.0	2200.9	129.7	3084.0	129.7
1985	23522	19964	318335	16.95	0.0	0.0	31.1	0.0	44.3	34.3	75.4	34.3
	23523	19975	320079	17.02	0.0	0.0	31.3	27.1	44.5	0.0	75.8	27.1
	23524	20127	321701	16.98	0.0	0.0	93.6	27.0	44.4	0.0	138.0	27.0
	23525	20038	273848	14.67	0.0	42.3	80.8	0.0	76.6	29.7	157.5	72.0
	23554	20110	274832	14.67	0.0	0.0	53.9	69.9	95.8	0.0	149.7	69.9
	23555	20096	274640	14.67	0.0	0.0	80.8	23.3	19.2	29.7	100.0	53.0
	23556	20145	284309	15.11	48.2	0.0	111.1	0.0	19.7	0.0	179.0	0.0
	23557	20110	283815	15.11	0.0	0.0	55.5	24.0	138.2	0.0	193.7	24.0
	23558	20096	283618	15.11	48.2	0.0	111.1	144.2	98.7	30.6	258.0	174.8
	23645	24843	98507	4.97	0.0	28.6	9.1	31.6	6.5	0.0	15.6	60.2
	Subtotal	205504	2733684		96.4	70.9	658.4	347.1	587.9	124.4	1342.7	542.4
1984	23322	24584	316880	13.89	44.3	80.1	25.5	66.2	72.6	253.3	142.4	399.6
	23323	24538	316288	13.89	0.0	40.0	102.1	242.9	54.4	337.7	156.5	620.6

Table 24. Estimates of total escapement of hatchery reared chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The expansion factor is used to expand the estimated number of adipose clipped chinook in the escapement (from Table 21) to account for unclipped hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (adipose clipped + unclipped releases) / adipose clipped releases.

Brood year	CWT release group	Release Numbers (d) Clipped	Release Numbers (d) Unclipped	Expansion Factor	Expanded hatchery contribution (a) Campbell River M(b)	Campbell River F	Quinsam River M	Quinsam River F	Quinsam Hatchery (c) M	Quinsam Hatchery (c) F	Total M	Total F
	23324	24527	316145	13.89	44.3	160.1	153.1	132.5	36.3	225.1	233.7	517.8
	23325	26157	305357	12.67	0.0	36.5	116.4	403.0	33.1	462.2	149.5	901.7
	23326	24937	291114	12.67	80.9	73.1	116.4	322.4	49.7	487.9	247.0	883.3
	23327	23714	276837	12.67	121.3	0.0	116.4	261.9	132.5	462.2	370.2	724.2
	23328	24520	314825	13.84	44.2	39.9	279.7	440.0	180.8	420.6	504.7	900.5
	23329	29735	369662	13.43	85.7	77.4	148.1	341.6	70.2	408.2	304.0	827.3
	23330	24508	314675	13.84	88.3	39.9	101.7	330.0	72.3	364.5	262.3	734.4
	82351	10165	0	1.00	0.0	0.0	0.0	9.5	2.6	8.1	2.6	17.6
	82352	10860	0	1.00	0.0	2.9	3.7	11.1	1.3	2.0	5.0	16.0
	82353	10567	0	1.00	0.0	5.8	16.5	11.1	2.6	2.0	19.1	18.9
	82354	10823	0	1.00	0.0	2.9	3.7	4.8	0.0	2.0	3.7	9.7
	82355	10659	0	1.00	6.4	8.6	3.7	6.4	0.0	0.0	10.1	15.0
	82356	10519	0	1.00	0.0	5.8	5.5	9.5	0.0	6.1	5.5	21.4
	82357	10808	0	1.00	0.0	2.9	3.7	11.1	0.0	4.1	3.7	18.1
	82358	10598	0	1.00	0.0	0.0	1.8	6.4	1.3	2.0	3.1	8.4
	82359	10459	5	1.00	3.2	5.8	5.5	12.7	0.0	2.0	8.7	20.5
	82360	10882	5	1.00	0.0	2.9	1.8	0.0	1.3	2.0	3.1	4.9
	82361	10640	5	1.00	0.0	0.0	0.0	4.8	0.0	0.0	0.0	4.8
	82362	10588	0	1.00	0.0	8.6	0.0	3.2	0.0	6.1	0.0	17.9
	Subtotal	354788	2821797		518.6	593.2	1205.5	2631.2	711.0	3458.3	2435.0	6682.7
1983	82259	11637	3	1.00	0.0	0.0	0.0	1.6	0.0	0.0	0.0	1.6
	Subtotal	11637	3		0.0	0.0	0.0	1.6	0.0	0.0	0.0	1.6
Total hatchery					666.2	664.1	2695.8	2979.9	3499.8	3712.4	6861.8	7356.4
Strays: (e)												
1986	24704	24567	0	1.00	3.2	0.0	0.0	0.0	0.0	0.0	3.2	0.0

Table 24. Estimates of total escapement of hatchery reared chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The expansion factor is used to expand the estimated number of adipose clipped chinook in the escapement (from Table 21) to account for unclipped hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (adipose clipped + unclipped releases) / adipose clipped releases.

Brood year	CWT release group	Release Numbers (d)		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery (c)		Total	
		Clipped	Unclipped		M(b)	F	M	F	M	F	M	F
1985	24030	24987	0	1.00	3.2	0.0	0.0	0.0	0.0	0.0	3.2	0.0
1985	24104	50048	0	1.00	3.2	2.9	0.0	0.0	0.0	0.0	3.2	2.9
Total strays					9.6	2.9	0.0	0.0	0.0	0.0	9.6	2.9

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) Includes adipose clips recovered at the rack and above the Quinsam River fence. See Appendix A13 for segregated CWT results.

(d) From Table 23

(e) Adipose clipped fish that have strayed to the system from other enhncement facilities

Table 25. Estimates of total escapement of hatchery reared chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The expansion factor is used to expand the estimated number of adipose clipped chinook in the escapement (from Table 22) to account for unclipped hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (adipose clipped + unclipped releases) / adipose clipped releases.

Brood year	CWT release group	Release Numbers (c)		Expansion Factor	Expanded hatchery contributions (a)							
					Campbell River		Quinsam River		Quinsam Hatchery		Total	
		Clipped	Unclipped		M(b)	F	M	F	M	F	M	F
1987	24419	24931	333010	14.36	0.0	0.0	38.2	0.0	43.9	0.0	82.1	0.0
	24420	24858	332048	14.36	0.0	0.0	0.0	0.0	43.9	0.0	43.9	0.0
	24421	24960	333409	14.36	0.0	0.0	0.0	0.0	21.9	0.0	21.9	0.0
	24736	21006	65112	4.10	0.0	0.0	10.9	0.0	12.5	0.0	23.4	0.0
	24737	21006	65112	4.10	0.0	0.0	10.9	0.0	0.0	0.0	10.9	0.0
	25359	25206	310514	13.32	0.0	0.0	0.0	0.0	20.4	0.0	20.4	0.0
	25360	25315	311859	13.32	0.0	0.0	0.0	0.0	40.7	0.0	40.7	0.0
	25361	24979	328344	14.15	0.0	0.0	75.2	0.0	21.6	0.0	96.8	0.0
	25363	24691	51015	3.07	0.0	0.0	16.3	0.0	4.7	0.0	21.0	0.0
	Subtotal	216952	2130423		0.0	0.0	151.5	0.0	209.7	0.0	361.1	0.0
1986	24152	19947	276591	14.87	0.0	0.0	158.1	206.2	90.9	111.0	249.0	317.2
	24153	19935	276591	14.87	74.4	0.0	39.5	206.3	159.2	27.8	273.1	234.1
	24154	19990	276591	14.84	74.2	0.0	78.9	68.6	136.1	83.1	289.1	151.7
	24155	18978	467555	25.64	0.0	0.0	136.3	0.0	195.9	143.6	332.2	143.6
	24156	20006	467555	24.37	0.0	0.0	194.4	169.0	186.3	136.5	380.6	305.5
	24157	19982	467555	24.40	0.0	0.0	194.6	112.8	410.2	45.5	604.8	158.3
	24158	19980	299513	15.99	0.0	88.4	127.5	184.8	122.2	238.8	249.7	512.0
	24159	19899	299513	16.05	0.0	0.0	85.3	148.4	171.8	119.9	257.1	268.3
	24160	19979	299513	15.99	0.0	88.4	127.5	110.9	195.6	209.0	323.1	408.3
	Subtotal	178696	3130977		148.6	176.8	1142.2	1207.1	1668.1	1115.0	2958.9	2499.0
1985	23522	19964	318335	16.95	0.0	0.0	0.0	78.3	0.0	0.0	0.0	78.3
	23523	19975	320079	17.02	0.0	0.0	45.3	0.0	0.0	95.3	45.3	95.3
	23524	20127	321701	16.98	169.8	93.9	45.2	157.0	0.0	0.0	215.0	251.0
	23525	20038	273848	14.67	0.0	0.0	0.0	67.8	0.0	0.0	0.0	67.8

Table 25. Estimates of total escapement of hatchery reared chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The expansion factor is used to expand the estimated number of adipose clipped chinook in the escapement (from Table 22) to account for unclipped hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (adipose clipped + unclipped releases) / adipose clipped releases.

Brood year	CWT release group	Release Numbers (c)		Expansion Factor	Expanded hatchery contributions (a)							
					Campbell River		Quinsam River		Quinsam Hatchery		Total	
		Clipped	Unclipped		M(b)	F	M	F	M	F	M	F
	23554	20110	274832	14.67	0.0	81.1	0.0	135.6	0.0	54.8	0.0	271.5
	23555	20096	274640	14.67	0.0	162.2	39.0	169.5	0.0	0.0	39.0	331.7
	23556	20145	284309	15.11	75.6	83.6	40.2	209.6	0.0	0.0	115.7	293.2
	23557	20110	283815	15.11	0.0	0.0	40.2	104.8	0.0	28.2	40.2	133.0
	23558	20096	283618	15.11	75.6	167.1	120.5	244.6	0.0	56.4	196.1	468.1
	23645	24843	98507	4.97	0.0	54.9	26.4	45.9	0.0	9.3	26.4	110.1
	Subtotal	205504	2733684		321.0	642.8	356.7	1213.2	0.0	244.0	677.7	2100.0
1984	23322	24584	316880	13.89	0.0	0.0	0.0	0.0	0.0	25.9	0.0	25.9
	23323	24538	316288	13.89	0.0	0.0	0.0	32.1	0.0	0.0	0.0	32.1
	23324	24527	316145	13.89	0.0	76.8	0.0	32.1	0.0	0.0	0.0	108.9
	23325	26157	305357	12.67	0.0	70.1	0.0	0.0	0.0	0.0	0.0	70.1
	23326	24937	291114	12.67	0.0	0.0	0.0	0.0	0.0	23.7	0.0	23.7
	23329	29735	369662	13.43	0.0	0.0	0.0	93.1	0.0	0.0	0.0	93.1
	23330	24508	314675	13.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	82352	10860	0	1.00	0.0	0.0	0.0	6.9	0.0	0.0	0.0	6.9
	82354	10823	0	1.00	5.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0
	82355	10659	0	1.00	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.3
	82356	10519	0	1.00	0.0	0.0	2.7	0.0	0.0	0.0	2.7	0.0
	Subtotal	221848	2230120		5.0	146.9	2.7	166.6	0.0	49.6	7.7	363.1
Total hatchery					474.5	966.5	1501.6	2586.9	1668.1	1408.6	3644.2	4962.1
Strays: (d)												
1986	24703	26423	0	1.00	0.0	5.5	0.0	0.0	0.0	0.0	0.0	5.5

Table 25. Estimates of total escapement of hatchery reared chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The expansion factor is used to expand the estimated number of adipose clipped chinook in the escapement (from Table 22) to account for unclipped hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (adipose clipped + unclipped releases) / adipose clipped releases.

Brood year	CWT release group	Release Numbers (c) Clipped	Release Numbers (c) Unclipped	Expansion Factor	Expanded hatchery contributions (a) Campbell River M(b)	Campbell River F	Quinsam River M	Quinsam River F	Quinsam Hatchery M	Quinsam Hatchery F	Total M	Total F
1985	24704	24567	0	1.00	5.0	5.5	0.0	0.0	0.0	0.0	5.0	5.5
1985	24104	50048	0	1.00	0.0	11.1	0.0	0.0	0.0	0.0	0.0	11.1
Total strays					5.0	22.1	0.0	0.0	0.0	0.0	5.0	22.1

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) From Table 23

(d) Adipose clipped fish that have strayed to the system from other enhancement facilities

Table 26. Estimated hatchery and stray contributions to Campbell River, Quinsam River and Quinsam Hatchery chinook salmon escapement, 1989. Contributions were calculated using expansion Method A for the estimated number of adipose clips (Table 24).

				Hatchery contribution (b)				Stray contribution (b)			
		Estimated escapement (a)		Male		Female		Male		Female	
Area	Age	Male (c)	Female	Number	%	Number	%	Number	%	Number	%
Campbell River											
	2.1	0	0	0		0		0		0	
	3.1	85	0	51	60.2	0		3	3.5	0	
	4.1	222	80	96	43.2	71	88.8	6	2.7	3	3.8
	5.1	639	1135	519	81.2	593	52.2	0	0.0	0	0.0
	6.1	7	18	0	0.0	0	0.0	0	0.0	0	0.0
	Total	953	1233	666	69.9	664	53.9	9	0.9	3	0.2
Quinsam River											
	2.1	0	0	26		0		0		0	
	3.1	947	0	832	87.9	0		0	0.0	0	
	4.1	641	398	658	100.0 (e)	347	87.2	0	0.0	0	0.0
	5.1	1668	2847	1206	72.3	2631	92.4	0	0.0	0	0.0
	6.1	0	16	0		2	12.5	0		0	0.0
	Total	3256	3261	2696	82.8	2980	91.4	0	0.0	0	0.0
Quinsam Hatchery (d)											
	2.1	22	0	19	86.4	0		0	0.0	0	
	3.1	1649	68	2201	100.0 (e)	130	100.0 (e)	0	0.0	0	0.0
	4.1	893	326	588	65.8	124	38.0	0	0.0	0	0.0
	5.1	1125	2034	711	63.2	3458	100.0 (e)	0	0.0	0	0.0
	6.1	0	5	0		0	0.0	0		0	0.0
	Total	3689	2433	3519	95.4	3712	100.0 (e)	0	0.0	0	0.0

(a) From Table 17
(b) From Table 24
(c) Includes jacks
(d) Hatchery estimates consist of rack recoveries and fish passed above the fence or fence swim throughs
(e) Estimated hatchery contribution greater than 100%

Table 27. Estimated hatchery contribution to Campbell River, Quinsam River and Quinsam Hatchery chinook salmon escapement, 1990. Contributions were calculated using expansion Method A for the estimated number of adipose clips (Table 25).

				Hatchery contribution (b)				Stray contribution (b)			
		Estimated escapement (a)		Male		Female		Male		Female	
Area	Age	Male (c)	Female	Number	%	Number	%	Number	%	Number	%
Campbell River											
	3.1	71	9	0	0.0	0	0.0	0	0.0	0	0.0
	4.1	875	484	149	17.0	177	36.6	0	0.0	6	1.2
	5.1	682	994	321	47.1	643	64.7	5	0.7	17	1.7
	6.1	71	260	5	7.0	147	56.5	0	0.0	0	0.0
	Total	1699	1747	475	28.0	967	55.4	5	0.3	23	1.3
Quinsam River											
	2.1	34	0	0	0.0	0		0	0.0	0	
	3.1	123	0	151	100.0 (e)	0		0	0.0	0	
	4.1	1833	1924	1142	62.3	1207	62.7	0	0.0	0	0.0
	5.1	839	1626	357	42.6	1213	74.6	0	0.0	0	0.0
	6.1	34	267	3	8.8	167	62.5	0	0.0	0	0.0
	Total	2863	3817	1653	57.7	2587	67.8	0	0.0	0	0.0
Quinsam Hatchery (d)											
	2.1	33	0	0	0.0	0		0	0.0	0	
	3.1	300	7	210	70.0	0	0.0	0	0.0	0	0.0
	4.1	2597	2135	1668	64.2	1115	52.2	0	0.0	0	0.0
	5.1	69	249	0	0.0	244	98.0	0	0.0	0	0.0
	6.1	0	22	0		50	100.0 (e)	0		0	0.0
	Total	2999	2413	1878	62.6	1409	58.4	0	0.0	0	0.0

(a) From Table 18
(b) From Table 25
(c) Includes jacks
(d) Hatchery estimates include rack recoveries and fish passed above the fence
(e) Estimated hatchery contribution greater than 100%

Table 28. Estimates of the adjusted number of CWT chinook salmon observed in the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. (Method B). One decimal place is carried for computations.

Brood year	CWT code	Campbell River (a) Observed CWTs M (b)	F	Campbell River (a) Adjusted CWTs M	F	Quinsam River Observed CWTs M	F	Quinsam River Adjusted CWTs M	F	Quinsam Hatchery (c) Observed CWTs M	F	Quinsam Hatchery (c) Adjusted CWTs M	F	Total Observed CWTs M	F	Total Adjusted CWTs M	F
1987	24419	0	0	0.0	0.0	1	0	1.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0
	24956	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0	1	0	1.0	0.0
	Total	0	0	0.0	0.0	1	0	1.0	0.0	1	0	1.0	0.0	2	0	2.0	0.0
1986	24152	0	0	0.0	0.0	2	0	2.0	0.0	15	0	15.2	0.0	17	0	17.2	0.0
	24153	0	0	0.0	0.0	5	0	5.0	0.0	10	0	10.1	0.0	15	0	15.1	0.0
	24154	0	0	0.0	0.0	6	0	6.0	0.0	11	0	11.1	0.0	17	0	17.2	0.0
	24155	0	0	0.0	0.0	1	0	1.0	0.0	3	0	3.0	0.0	4	0	4.0	0.0
	24156	0	0	0.0	0.0	2	0	2.0	0.0	6	0	6.1	0.0	8	0	8.1	0.0
	24157	0	0	0.0	0.0	3	0	3.0	0.0	15	0	15.2	0.0	18	0	18.2	0.0
	24158	0	0	0.0	0.0	2	0	2.0	0.0	3	1	3.0	1.0	5	1	5.0	1.0
	24159	1	0	1.0	0.0	2	0	2.0	0.0	17	1	17.2	1.0	20	1	20.2	1.0
	24160	0	0	0.0	0.0	3	0	3.0	0.0	15	2	15.2	2.0	18	2	18.2	2.0
	Subtotal	1	0	1.0	0.0	26	0	26.2	0.0	95	4	96.0	4.0	122	4	123.3	4.0
1985	23522	0	0	0.0	0.0	1	0	1.0	0.0	2	1	2.0	1.0	3	1	3.0	1.0
	23523	0	0	0.0	0.0	1	1	1.0	1.0	2	0	2.0	0.0	3	1	3.0	1.0
	23524	0	0	0.0	0.0	3	1	3.0	1.0	2	0	2.0	0.0	5	1	5.0	1.0
	23525	0	1	0.0	1.0	3	0	3.0	0.0	4	1	4.0	1.0	7	2	7.1	2.0
	23554	0	0	0.0	0.0	2	3	2.0	3.0	5	0	5.1	0.0	7	3	7.1	3.0
	23555	0	0	0.0	0.0	3	1	3.0	1.0	1	1	1.0	1.0	4	2	4.0	2.0
	23556	1	0	1.0	0.0	4	0	4.0	0.0	1	0	1.0	0.0	6	0	6.1	0.0
	23557	0	0	0.0	0.0	2	1	2.0	1.0	7	0	7.1	0.0	9	1	9.1	1.0
	23558	1	0	1.0	0.0	4	6	4.0	6.0	5	1	5.1	1.0	10	7	10.1	7.0
	23645	0	2	0.0	2.0	1	4	1.0	4.0	1	0	1.0	0.0	2	6	2.0	6.0
	Subtotal	2	3	2.1	3.0	24	17	24.2	17.1	30	4	30.3	4.0	56	24	56.6	24.1

Table 28. Estimates of the adjusted number of CWT chinook salmon observed in the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. (Method B). One decimal place is carried for computations.

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1984	23322	1	2	1.0	2.0	1	3	1.0	3.0	4	9	4.0	9.1	6	14	6.1	14.1
	23323	0	1	0.0	1.0	4	11	4.0	11.1	3	12	3.0	12.1	7	24	7.1	24.2
	23324	1	4	1.0	4.0	6	6	6.0	6.0	2	8	2.0	8.1	9	18	9.1	18.1
	23325	0	1	0.0	1.0	5	20	5.0	20.1	2	18	2.0	18.2	7	39	7.1	39.3
	23326	2	2	2.1	2.0	5	16	5.0	16.1	3	19	3.0	19.2	10	37	10.2	37.3
	23327	3	0	3.1	0.0	5	13	5.0	13.1	8	18	8.1	18.2	16	31	16.3	31.3
	23328	1	1	1.0	1.0	11	20	11.1	20.1	10	15	10.1	15.2	22	36	22.2	36.3
	23329	2	2	2.1	2.0	6	16	6.0	16.1	4	15	4.0	15.2	12	33	12.2	33.3
	23330	2	1	2.1	1.0	4	15	4.0	15.1	4	13	4.0	13.2	10	29	10.2	29.2
	82351	0	0	0.0	0.0	0	6	0.0	6.0	2	4	2.0	4.0	2	10	2.0	10.1
	82352	0	1	0.0	1.0	2	7	2.0	7.0	1	1	1.0	1.0	3	9	3.0	9.0
	82353	0	2	0.0	2.0	9	7	9.1	7.0	2	1	2.0	1.0	11	10	11.1	10.0
	82354	0	1	0.0	1.0	2	3	2.0	3.0	0	1	0.0	1.0	2	5	2.0	5.0
	82355	2	3	2.1	3.0	2	4	2.0	4.0	0	0	0.0	0.0	4	7	4.1	7.0
	82356	0	2	0.0	2.0	3	6	3.0	6.0	0	3	0.0	3.0	3	11	3.0	11.1
	82357	0	1	0.0	1.0	2	7	2.0	7.0	0	2	0.0	2.0	2	10	2.0	10.1
	82358	0	0	0.0	0.0	1	4	1.0	4.0	1	1	1.0	1.0	2	5	2.0	5.0
	82359	1	2	1.0	2.0	3	8	3.0	8.0	0	1	0.0	1.0	4	11	4.1	11.1
	82360	0	1	0.0	1.0	1	0	1.0	0.0	1	1	1.0	1.0	2	2	2.0	2.0
	82361	0	0	0.0	0.0	0	3	0.0	3.0	0	0	0.0	0.0	0	3	0.0	3.0
	82362	0	3	0.0	3.0	0	2	0.0	2.0	0	3	0.0	3.0	0	8	0.0	8.0
	Subtotal	15	30	15.6	30.0	72	177	72.6	177.9	47	145	47.5	146.7	134	352	135.7	354.6
1983	82259	0	0	0.0	0.0	0	1	0.0	1.0	0	0	0.0	0.0	0	1	0.0	1.0
	Subtotal	0	0	0.0	0.0	0	1	0.0	1.0	0	0	0.0	0.0	0	1	0.0	1.0

Table 28. Estimates of the adjusted number of CWT chinook salmon observed in the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. (Method B). One decimal place is carried for computations.

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Total hatchery		18	33	18.8	33.0	123	195	124.0	196.0	173	153	174.9	154.8	314	381	317.6	383.8
Strays: (d)																	
1986	24704	1	0	1.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0
1985	24030	1	0	1.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0
1985	24104	1	1	1.0	1.0	0	0	0.0	0.0	0	0	0.0	0.0	1	1	1.0	1.0
Total strays		3	1	3.1	1.0	0	0	0.0	0.0	0	0	0.0	0.0	3	1	3.1	1.0
Total CWT		21	34	21.9	34.0	123	195	124.0	196.0	173	153	174.9	154.8	317	382	320.8	384.8
No data (5000)		1	0			0	0			2	2			3	2		
No pin (8000)		3	6			17	21			11	19			31	46		
Lost pin (9000)		0	0			1	1			0	0			1	1		
Observed adipose		25	40			141	217			186	174			352	431		

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) Includes adipose clips recovered at the rack and above the Quinsam River fence. See Appendix A13 for segregated CWT results.

(d) CWT fish that have strayed to the system from other enhancement facilities

Table 29. Estimates of the adjusted number of CWT chinook salmon observed in the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. (Method B). One decimal place is carried for computations.

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1987	24419	0	0	0.0	0.0	1	0	1.0	0.0	2	0	2.0	0.0	3	0	3.0	0.0
	24420	0	0	0.0	0.0	0	0	0.0	0.0	2	0	2.0	0.0	2	0	2.0	0.0
	24421	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0	1	0	1.0	0.0
	24736	0	0	0.0	0.0	1	0	1.0	0.0	2	0	2.0	0.0	3	0	3.0	0.0
	24737	0	0	0.0	0.0	1	0	1.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0
	25359	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0	1	0	1.0	0.0
	25360	0	0	0.0	0.0	0	0	0.0	0.0	2	0	2.0	0.0	2	0	2.0	0.0
	25361	0	0	0.0	0.0	2	0	2.0	0.0	1	0	1.0	0.0	3	0	3.0	0.0
	25363	0	0	0.0	0.0	2	0	2.0	0.0	1	0	1.0	0.0	3	0	3.0	0.0
	Total	0	0	0.0	0.0	7	0	7.0	0.0	12	0	12.0	0.0	19	0	19.0	0.0
1986	24152	0	0	0.0	0.0	4	6	4.0	6.2	4	4	4.0	4.0	8	10	8.0	10.2
	24153	1	0	1.0	0.0	1	6	1.0	6.2	7	1	7.0	1.0	9	7	9.0	7.2
	24154	1	0	1.0	0.0	2	2	2.0	2.1	6	3	6.0	3.0	9	5	9.0	5.1
	24155	0	0	0.0	0.0	2	0	2.0	0.0	5	3	5.0	3.0	7	3	7.0	3.0
	24156	0	0	0.0	0.0	3	3	3.0	3.1	5	3	5.0	3.0	8	6	8.0	6.1
	24157	0	0	0.0	0.0	3	2	3.0	2.1	11	1	11.0	1.0	14	3	14.0	3.1
	24158	0	1	0.0	1.0	3	5	3.0	5.2	5	8	5.0	8.0	8	14	8.0	14.2
	24159	0	0	0.0	0.0	2	4	2.0	4.2	7	4	7.0	4.0	9	8	9.0	8.2
	24160	0	1	0.0	1.0	3	3	3.0	3.1	8	7	8.0	7.0	11	11	11.0	11.1
	Subtotal	2	2	2.0	2.0	23	31	23.0	32.2	58	34	58.0	34.0	83	67	83.0	68.2
1985	23522	0	0	0.0	0.0	0	2	0.0	2.1	0	0	0.0	0.0	0	2	0.0	2.1
	23523	0	0	0.0	0.0	1	0	1.0	0.0	0	3	0.0	3.0	1	3	1.0	3.0
	23524	2	1	2.0	1.0	1	4	1.0	4.2	0	0	0.0	0.0	3	5	3.0	5.2
	23525	0	0	0.0	0.0	0	2	0.0	2.1	0	0	0.0	0.0	0	2	0.0	2.1
	23554	0	1	0.0	1.0	0	4	0.0	4.2	0	2	0.0	2.0	0	7	0.0	7.2
	23555	0	2	0.0	2.0	1	5	1.0	5.2	0	0	0.0	0.0	1	7	1.0	7.2

Table 29. Estimates of the adjusted number of CWT chinook salmon observed in the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. (Method B). One decimal place is carried for computations.

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
	23556	1	1	1.0	1.0	1	6	1.0	6.2	0	0	0.0	0.0	2	7	2.0	7.2
	23557	0	0	0.0	0.0	1	3	1.0	3.1	0	1	0.0	1.0	1	4	1.0	4.1
	23558	1	2	1.0	2.0	3	7	3.0	7.3	0	2	0.0	2.0	4	11	4.0	11.3
	23645	0	2	0.0	2.0	2	4	2.0	4.2	0	1	0.0	1.0	2	7	2.0	7.2
	Subtotal	4	9	4.0	9.0	10	37	10.0	38.4	0	9	0.0	9.0	14	55	14.0	56.4
1984	23322	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	1.0	0	1	0.0	1.0
	23323	0	0	0.0	0.0	0	1	0.0	1.0	0	0	0.0	0.0	0	1	0.0	1.0
	23324	0	1	0.0	1.0	0	1	0.0	1.0	0	0	0.0	0.0	0	2	0.0	2.0
	23325	0	1	0.0	1.0	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	1.0
	23326	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	1.0	0	1	0.0	1.0
	23329	0	0	0.0	0.0	0	3	0.0	3.1	0	0	0.0	0.0	0	3	0.0	3.1
	23330	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0
	82352	0	0	0.0	0.0	0	3	0.0	3.1	0	0	0.0	0.0	0	3	0.0	3.1
	82354	1	0	1.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0
	82355	0	0	0.0	0.0	0	1	0.0	1.0	0	0	0.0	0.0	0	1	0.0	1.0
	82356	0	0	0.0	0.0	1	0	1.0	0.0	0	0	0.0	0.0	1	0	1.0	0.0
	Subtotal	1	2	1.0	2.0	1	9	1.0	9.4	0	2	0.0	2.0	2	13	2.0	13.4
Total hatchery		7	13	7.0	13.0	41	77	41.0	80.0	70	45	70.0	45.0	118	135	118.0	138.0
Strays: (c)														0	0	0.0	0.0
1986	24703	0	1	0.0	1.0	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.0	1.0
1986	24704	1	1	1.0	1.0	0	0	0.0	0.0	0	0	0.0	0.0	1	1	1.0	1.0
1985	24104	0	2	0.0	2.0	0	0	0.0	0.0	0	0	0.0	0.0	0	2	0.0	2.0
Total strays		1	4	1.0	4.0	0	0	0.0	0.0	0	0	0.0	0.0	1	4	1.0	4.0

Table 29. Estimates of the adjusted number of CWT chinook salmon observed in the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. (Method B). One decimal place is carried for computations.

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs		Observed CWTs		Adjusted CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Total CWT		8	17	8.0	17.0	41	77	41.0	80.0	70	45	70.0	45.0	119	139	119.0	142.0
No data (5000)		0	0			0	0			0	0			0	0		
No pin (8000)		0	1			9	7			1	7			10	15		
Lost pin (9000)		0	0			0	3			0	0			0	3		
Observed adipose		8	18			50	87			71	52			129	157		

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) CWT fish that have strayed to the system from other enhancement facilities

Table 30. Estimates of total escapement of CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated CWTs for calculating the expanded hatchery contributions in Table 32 (Method B).

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1987	24419	0.0	0.0	0.0	0.0	1.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.7	0.0
	24956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.2	0.0	1.0	0.0	1.2	0.0
	Total	0.0	0.0	0.0	0.0	1.0	0.0	1.7	0.0	1.0	0.0	1.2	0.0	2.0	0.0	2.9	0.0
1986	24152	0.0	0.0	0.0	0.0	2.0	0.0	3.4	0.0	15.1	0.0	17.3	0.0	17.1	0.0	20.7	0.0
	24153	0.0	0.0	0.0	0.0	5.0	0.0	8.5	0.0	10.1	0.0	11.5	0.0	15.1	0.0	20.0	0.0
	24154	0.0	0.0	0.0	0.0	6.0	0.0	10.2	0.0	11.1	0.0	12.7	0.0	17.1	0.0	22.9	0.0
	24155	0.0	0.0	0.0	0.0	1.0	0.0	1.7	0.0	3.0	0.0	3.5	0.0	4.0	0.0	5.2	0.0
	24156	0.0	0.0	0.0	0.0	2.0	0.0	3.4	0.0	6.0	0.0	6.9	0.0	8.0	0.0	10.3	0.0
	24157	0.0	0.0	0.0	0.0	3.0	0.0	5.1	0.0	15.1	0.0	17.3	0.0	18.1	0.0	22.4	0.0
	24158	0.0	0.0	0.0	0.0	2.0	0.0	3.4	0.0	3.0	1.0	3.5	1.2	5.0	1.0	6.9	1.2
	24159	1.0	0.0	2.8	0.0	2.0	0.0	3.4	0.0	17.1	1.0	19.6	1.2	20.2	1.0	25.8	1.2
	24160	0.0	0.0	0.0	0.0	3.0	0.0	5.1	0.0	15.1	2.0	17.3	2.5	18.1	2.0	22.4	2.5
	Subtotal	1.0	0.0	2.8	0.0	26.2	0.0	44.4	0.0	95.5	4.0	109.3	5.0	122.8	4.0	156.4	5.0
1985	23522	0.0	0.0	0.0	0.0	1.0	0.0	1.7	0.0	2.0	1.0	2.3	1.2	3.0	1.0	4.0	1.2
	23523	0.0	0.0	0.0	0.0	1.0	1.0	1.7	1.4	2.0	0.0	2.3	0.0	3.0	1.0	4.0	1.4
	23524	0.0	0.0	0.0	0.0	3.0	1.0	5.1	1.4	2.0	0.0	2.3	0.0	5.0	1.0	7.4	1.4
	23525	0.0	1.0	0.0	2.4	3.0	0.0	5.1	0.0	4.0	1.0	4.6	1.2	7.0	2.0	9.7	3.7
	23554	0.0	0.0	0.0	0.0	2.0	3.0	3.4	4.3	5.0	0.0	5.8	0.0	7.0	3.0	9.2	4.3
	23555	0.0	0.0	0.0	0.0	3.0	1.0	5.1	1.4	1.0	1.0	1.2	1.2	4.0	2.0	6.3	2.7
	23556	1.0	0.0	2.8	0.0	4.0	0.0	6.8	0.0	1.0	0.0	1.2	0.0	6.1	0.0	10.8	0.0
	23557	0.0	0.0	0.0	0.0	2.0	1.0	3.4	1.4	7.0	0.0	8.1	0.0	9.1	1.0	11.5	1.4
	23558	1.0	0.0	2.8	0.0	5.0	6.0	8.5	8.6	4.0	1.0	4.6	1.2	10.1	7.0	15.9	9.9
	23645	0.0	2.0	0.0	4.9	1.0	4.0	1.7	5.7	1.0	0.0	1.2	0.0	2.0	6.0	2.9	10.6
	Subtotal	2.1	3.0	5.6	7.3	25.2	17.1	42.7	24.4	29.2	4.0	33.4	5.0	56.4	24.1	81.6	36.7

Table 30. Estimates of total escapement of CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated CWTs for calculating the expanded hatchery contributions in Table 32 (Method B).

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1984	23322	1.0	2.0	2.8	4.9	1.0	3.0	1.7	4.3	4.0	9.0	4.6	11.2	6.1	14.0	9.1	20.4
	23323	0.0	1.0	0.0	2.4	4.0	11.1	6.8	15.8	3.0	12.0	3.5	14.9	7.0	24.1	10.3	33.1
	23324	1.0	4.0	2.8	9.8	6.0	6.0	10.2	8.6	2.0	8.0	2.3	9.9	9.1	18.0	15.3	28.3
	23325	0.0	1.0	0.0	2.4	5.0	20.1	8.5	28.7	2.0	18.0	2.3	22.3	7.0	39.1	10.8	53.5
	23326	2.1	2.0	5.6	4.9	6.0	17.1	10.2	24.4	2.0	18.0	2.3	22.3	10.2	37.1	18.1	51.7
	23327	3.1	0.0	8.4	0.0	7.1	14.1	11.9	20.1	6.0	17.0	6.9	21.1	16.2	31.1	27.2	41.2
	23328	1.0	1.0	2.8	2.4	13.1	21.1	22.2	30.2	8.0	14.0	9.2	17.4	22.2	36.1	34.2	50.0
	23329	2.1	2.0	5.6	4.9	6.0	17.1	10.2	24.4	4.0	14.0	4.6	17.4	12.2	33.1	20.4	46.7
	23330	2.1	1.0	5.6	2.4	4.0	18.1	6.8	25.9	4.0	10.0	4.6	12.4	10.1	29.1	17.0	40.7
	82351	0.0	0.0	0.0	0.0	2.0	6.0	3.4	8.6	0.0	4.0	0.0	5.0	2.0	10.0	3.4	13.6
	82352	0.0	1.0	0.0	2.4	2.0	7.0	3.4	10.1	1.0	1.0	1.2	1.2	3.0	9.0	4.6	13.7
	82353	0.0	2.0	0.0	4.9	9.1	7.0	15.4	10.1	2.0	1.0	2.3	1.2	11.1	10.0	17.7	16.2
	82354	0.0	1.0	0.0	2.4	2.0	3.0	3.4	4.3	0.0	1.0	0.0	1.2	2.0	5.0	3.4	8.0
	82355	2.1	3.0	5.6	7.3	2.0	4.0	3.4	5.7	0.0	0.0	0.0	0.0	4.1	7.0	9.0	13.1
	82356	0.0	2.0	0.0	4.9	3.0	6.0	5.1	8.6	0.0	3.0	0.0	3.7	3.0	11.0	5.1	17.2
	82357	0.0	1.0	0.0	2.4	2.0	7.0	3.4	10.1	0.0	2.0	0.0	2.5	2.0	10.0	3.4	15.0
	82358	0.0	0.0	0.0	0.0	2.0	4.0	3.4	5.7	0.0	1.0	0.0	1.2	2.0	5.0	3.4	7.0
	82359	1.0	2.0	2.8	4.9	3.0	8.0	5.1	11.5	0.0	1.0	0.0	1.2	4.1	11.0	7.9	17.6
	82360	0.0	1.0	0.0	2.4	1.0	0.0	1.7	0.0	1.0	1.0	1.2	1.2	2.0	2.0	2.9	3.7
	82361	0.0	0.0	0.0	0.0	0.0	3.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	3.0	0.0	4.3
	82362	0.0	3.0	0.0	7.3	0.0	2.0	0.0	2.9	0.0	3.0	0.0	3.7	0.0	8.0	0.0	13.9
	Subtotal	15.7	30.0	41.8	73.2	80.6	184.9	136.5	264.5	39.2	138.0	44.9	171.3	135.5	352.9	223.2	509.0
1983	82259	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.4
	Subtotal	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.4

Table 30. Estimates of total escapement of CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated CWTs for calculating the expanded hatchery contributions in Table 32 (Method B).

		Campbell River (a)				Quinsam River				Quinsam Hatchery (c)				Total			
		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Total hatchery		18.9	33.0	50.2	80.6	133.0	203.0	225.2	290.3	164.9	146.0	188.6	181.2	316.8	382.0	464.0	552.1
Strays: (d)																	
1986	24704	1.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.8	0.0
1985	24030	1.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.8	0.0
1985	24104	1.0	1.0	2.8	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.8	2.4
Total strays		3.1	1.0	8.3	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.0	8.3	2.4
Petersen Estimate		953	1233			3256	3261			3689	2433						
Sample Size		358	505			1923	2280			3226	1960						

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) Includes adipose clips recovered at the rack and above the Quinsam River fence. See Appendix A13 for segregated CWT results.

(d) CWT fish that have strayed to the system from other enhancement facilities

Table 31. Estimates of total escapement of CWTchinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated CWTs for calculating the expanded hatchery contribution in Table 33. (Method B)

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1987	24419	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0	2.0	0.0	3.0	0.0	3.0	0.0	5.2	0.0
	24420	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.0	0.0	2.0	0.0	3.0	0.0
	24421	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.5	0.0	1.0	0.0	1.5	0.0
	24736	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0	2.0	0.0	3.0	0.0	3.0	0.0	5.2	0.0
	24737	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0
	25359	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.5	0.0	1.0	0.0	1.5	0.0
	25360	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.0	0.0	2.0	0.0	3.0	0.0
	25361	0.0	0.0	0.0	0.0	2.0	0.0	4.4	0.0	1.0	0.0	1.5	0.0	3.0	0.0	5.9	0.0
	25363	0.0	0.0	0.0	0.0	2.0	0.0	4.4	0.0	1.0	0.0	1.5	0.0	3.0	0.0	5.9	0.0
	Total	0.0	0.0	0.0	0.0	7.0	0.0	15.4	0.0	12.0	0.0	18.3	0.0	19.0	0.0	33.6	0.0
1986	24152	0.0	0.0	0.0	0.0	4.0	6.2	8.8	12.7	4.0	4.0	6.1	6.4	8.0	10.2	14.9	19.2
	24153	1.0	0.0	5.0	0.0	1.0	6.2	2.2	12.7	7.0	1.0	10.7	1.6	9.0	7.2	17.9	14.3
	24154	1.0	0.0	5.0	0.0	2.0	2.1	4.4	4.2	6.0	3.0	9.1	4.8	9.0	5.1	18.5	9.1
	24155	0.0	0.0	0.0	0.0	2.0	0.0	4.4	0.0	5.0	3.0	7.6	4.8	7.0	3.0	12.0	4.8
	24156	0.0	0.0	0.0	0.0	3.0	3.1	6.6	6.4	5.0	3.0	7.6	4.8	8.0	6.1	14.2	11.2
	24157	0.0	0.0	0.0	0.0	3.0	2.1	6.6	4.2	11.0	1.0	16.8	1.6	14.0	3.1	23.3	5.9
	24158	0.0	1.0	0.0	5.2	3.0	5.2	6.6	10.6	5.0	8.0	7.6	12.9	8.0	14.2	14.2	28.7
	24159	0.0	0.0	0.0	0.0	2.0	4.2	4.4	8.5	7.0	4.0	10.7	6.4	9.0	8.2	15.1	14.9
	24160	0.0	1.0	0.0	5.2	3.0	3.1	6.6	6.4	8.0	7.0	12.2	11.3	11.0	11.1	18.8	22.8
	Subtotal	2.0	2.0	10.0	10.4	23.0	32.2	50.5	65.7	58.0	34.0	88.3	54.7	83.0	68.2	148.9	130.9
1985	23522	0.0	0.0	0.0	0.0	0.0	2.1	0.0	4.2	0.0	0.0	0.0	0.0	0.0	2.1	0.0	4.2
	23523	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0	0.0	3.0	0.0	4.8	1.0	3.0	2.2	4.8
	23524	2.0	1.0	10.0	5.2	1.0	4.2	2.2	8.5	0.0	0.0	0.0	0.0	3.0	5.2	12.2	13.7
	23525	0.0	0.0	0.0	0.0	0.0	2.1	0.0	4.2	0.0	0.0	0.0	0.0	0.0	2.1	0.0	4.2
	23554	0.0	1.0	0.0	5.2	0.0	4.2	0.0	8.5	0.0	2.0	0.0	3.2	0.0	7.2	0.0	16.9

Table 31. Estimates of total escapement of CWTchinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated CWTs for calculating the expanded hatchery contribution in Table 33. (Method B)

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
	23555	0.0	2.0	0.0	10.4	1.0	5.2	2.2	10.6	0.0	0.0	0.0	0.0	1.0	7.2	2.2	21.0
	23556	1.0	1.0	5.0	5.2	1.0	6.2	2.2	12.7	0.0	0.0	0.0	0.0	2.0	7.2	7.2	17.9
	23557	0.0	0.0	0.0	0.0	1.0	3.1	2.2	6.4	0.0	1.0	0.0	1.6	1.0	4.1	2.2	8.0
	23558	1.0	2.0	5.0	10.4	3.0	7.3	6.6	14.8	0.0	2.0	0.0	3.2	4.0	11.3	11.6	28.5
	23645	0.0	2.0	0.0	10.4	2.0	4.2	4.4	8.5	0.0	1.0	0.0	1.6	2.0	7.2	4.4	20.5
	Subtotal	4.0	9.0	20.0	46.9	10.0	38.4	22.0	78.5	0.0	9.0	0.0	14.5	14.0	56.4	42.0	139.9
1984	23322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.6	0.0	1.0	0.0	1.6
	23323	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.1
	23324	0.0	1.0	0.0	5.2	0.0	1.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	2.0	0.0	7.3
	23325	0.0	1.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	5.2
	23326	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.6	0.0	1.0	0.0	1.6
	23329	0.0	0.0	0.0	0.0	0.0	3.1	0.0	6.4	0.0	0.0	0.0	0.0	0.0	3.1	0.0	6.4
	23330	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	82352	0.0	0.0	0.0	0.0	0.0	3.1	0.0	6.4	0.0	0.0	0.0	0.0	0.0	3.1	0.0	6.4
	82354	1.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	5.0	0.0
	82355	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.1
	82356	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.2	0.0
	Subtotal	1.0	2.0	5.0	0.0	1.0	9.4	2.2	19.1	0.0	2.0	0.0	3.2	2.0	13.4	7.2	22.3
Total hatchery		7.0	13.0	35.1	57.4	41.0	80.0	90.0	163.3	70.0	45.0	106.6	72.4	118.0	138.0	231.7	293.0
Strays: (c)																	
1986	24703	0.0	1.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	5.2
1986	24704	1.0	1.0	5.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	5.0	5.2
1985	24104	0.0	2.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	10.4

Table 31. Estimates of total escapement of CWTchinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The source of tags for the Petersen estimates was from in situ carcass tagging. One decimal place is carried for the estimated CWTs for calculating the expanded hatchery contribution in Table 33. (Method B)

		Campbell River (a)				Quinsam River				Quinsam Hatchery				Total			
		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs		Adjusted CWTs		Estimated CWTs	
Brood year	CWT code	M (b)	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Total strays		1.0	4.0	5.0	20.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.0	5.0	20.9
Petersen Estimate		1699	1747			2863	3817			2999	2413						
Sample Size		339	335			1304	1870			1969	1500						

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) CWT fish that have strayed to the system from other enhancement facilities

Table 32. Estimates of total escapement of hatchery reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The expansion factor is used to expand the estimated number of CWT chinook in the escapement (from Table 30) to account for unmarked hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (CWT + untagged releases) / CWT releases.

Brood year	CWT release group	Release Numbers		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery (d)		Total	
		CWT	Untagged (c)		M(b)	F	M	F	M	F	M	F
1987	24419	24457	333015	14.62	0.0	0.0	24.9	0.0	0.0	0.0	24.9	0.0
	24956	24641	330180	14.40	0.0	0.0	0.0	0.0	16.6	0.0	16.6	0.0
	Subtotal			29	0.0	0.0	24.9	0.0	16.6	0.0	41.5	0.0
1986	24152	19947	276591	14.87	0.0	0.0	50.7	0.0	256.4	0.0	307.2	0.0
	24153	19935	276591	14.87	0.0	0.0	126.9	0.0	171.1	0.0	297.9	0.0
	24154	19990	276591	14.84	0.0	0.0	151.9	0.0	187.7	0.0	339.6	0.0
	24155	18978	467555	25.64	0.0	0.0	43.7	0.0	88.4	0.0	132.2	0.0
	24156	20006	467555	24.37	0.0	0.0	83.2	0.0	168.2	0.0	251.3	0.0
	24157	19982	467555	24.40	0.0	0.0	124.9	0.0	420.9	0.0	545.8	0.0
	24158	19980	299513	15.99	0.0	0.0	54.6	0.0	55.2	19.8	109.7	19.8
	24159	19899	299513	16.05	44.8	0.0	54.8	0.0	313.8	19.9	413.3	19.9
	24160	19979	299513	15.99	0.0	0.0	81.8	0.0	275.9	39.7	357.7	39.7
	Subtotal				44.8	0.0	772.4	0.0	1937.5	79.5	2754.7	79.5
1985	23522	19964	318335	16.95	0.0	0.0	28.9	0.0	39.0	21.0	67.9	21.0
	23523	19975	320079	17.02	0.0	0.0	29.0	24.5	39.2	0.0	68.2	24.5
	23524	20127	321701	16.98	0.0	0.0	86.9	24.4	39.1	0.0	126.0	24.4
	23525	20038	273848	14.67	0.0	35.8	75.1	0.0	67.5	18.2	142.5	54.0
	23554	20110	274832	14.67	0.0	0.0	50.0	63.2	84.3	0.0	134.4	63.2
	23555	20096	274640	14.67	0.0	0.0	75.1	21.1	16.9	18.2	91.9	39.3
	23556	20145	284309	15.11	42.1	0.0	103.1	0.0	17.4	0.0	162.7	0.0
	23557	20110	283815	15.11	0.0	0.0	51.6	21.7	121.7	0.0	173.2	21.7
	23558	20096	283618	15.11	42.1	0.0	128.9	130.3	69.5	18.8	240.6	149.1
	23645	24843	98507	4.97	0.0	24.2	8.5	28.5	5.7	0.0	14.2	52.8
	Subtotal				84.3	60.1	637.1	313.8	500.1	76.2	1221.6	450.1
1984	23322	24584	316880	13.89	38.7	67.8	23.7	59.9	63.9	155.2	126.3	282.9

Table 32. Estimates of total escapement of hatchery reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The expansion factor is used to expand the estimated number of CWT chinook in the escapement (from Table 30) to account for unmarked hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (CWT + untagged releases) / CWT releases.

Brood year	CWT release group	Release Numbers		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery (d)		Total	
		CWT	Untagged (c)		M(b)	F	M	F	M	F	M	F
	23323	24538	316288	13.89	0.0	33.9	94.8	219.6	47.9	206.9	142.7	460.4
	23324	24527	316145	13.89	38.7	135.7	142.2	119.8	31.9	137.9	212.9	393.4
	23325	26157	305357	12.67	0.0	30.9	108.1	364.3	29.2	283.2	137.3	678.5
	23326	24937	291114	12.67	70.7	61.9	129.7	309.7	29.2	283.2	229.6	654.8
	23327	23714	276837	12.67	106.0	0.0	151.4	255.0	87.5	267.5	344.8	522.5
	23328	24471	314874	13.87	38.7	33.9	307.6	418.6	127.6	241.0	473.8	693.4
	23329	29676	369721	13.46	75.1	65.7	137.8	328.9	61.9	233.9	274.7	628.5
	23330	24459	314724	13.87	77.3	33.9	94.6	358.8	63.8	172.1	235.8	564.8
	82351	9657	508	1.05	0.0	0.0	3.6	9.1	0.0	5.2	3.6	14.3
	82352	10317	543	1.05	0.0	2.6	3.6	10.6	1.2	1.3	4.8	14.5
	82353	10039	528	1.05	0.0	5.1	16.2	10.6	2.4	1.3	18.6	17.0
	82354	10228	595	1.06	0.0	2.6	3.6	4.6	0.0	1.3	3.6	8.5
	82355	10073	586	1.06	5.9	7.8	3.6	6.1	0.0	0.0	9.5	13.8
	82356	9940	579	1.06	0.0	5.2	5.4	9.1	0.0	3.9	5.4	18.2
	82357	10332	471	1.05	0.0	2.6	3.6	10.5	0.0	2.6	3.6	15.7
	82358	10132	461	1.05	0.0	0.0	3.6	6.0	0.0	1.3	3.6	7.3
	82359	10009	455	1.05	2.9	5.1	5.4	12.0	0.0	1.3	8.3	18.4
	82360	10577	310	1.03	0.0	2.5	1.8	0.0	1.2	1.3	2.9	3.8
	82361	10342	303	1.03	0.0	0.0	0.0	4.4	0.0	0.0	0.0	4.4
	82362	10281	302	1.03	0.0	7.5	0.0	3.0	0.0	3.8	0.0	14.3
	Subtotal				454.1	504.6	1240.0	2520.5	547.6	2004.3	2241.7	5029.4
1983	82259	10834	806	1.07	0.0	0.0	0.0	1.5	0.0	0.0	0.0	1.5
	Subtotal				0.0	0.0	0.0	1.5	0.0	0.0	0.0	1.5
Total hatchery					583.2	564.6	2649.6	2835.9	2985.3	2159.9	6218.0	5560.5

Strays: (e)

Table 32. Estimates of total escapement of hatchery reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1989. The expansion factor is used to expand the estimated number of CWT chinook in the escapement (from Table 30) to account for unmarked hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (CWT + untagged releases) / CWT releases.

Brood year	CWT release group	Release Numbers		Expansion	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery (d)		Total	
		CWT	Untagged (c)	Factor	M(b)	F	M	F	M	F	M	F
1986	24704	24567	0	1.00	2.8	0.0	0.0	0.0	0.0	0.0	2.8	0.0
1985	24030	24987	0	1.00	2.8	0.0	0.0	0.0	0.0	0.0	2.8	0.0
1985	24104	49247	801	1.02	2.8	2.5	0.0	0.0	0.0	0.0	2.8	2.5
Total strays					8.4	2.5	0.0	0.0	0.0	0.0	8.4	2.5

(a) Abbreviations are M = male and F = female

(b) Includes jacks

(c) Untagged = AD only (i.e. tag lost) + unmarked (i.e. no CWT/AFC applied)

(d) Includes CWTs recovered at the rack and above the Quinsam River fence. See Appendix A13 for segregated CWT results.

(e) CWT fish that have strayed to the system from other enhancement facilities

Table 33. Estimates of total escapement of hatchery reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The expansion factor is used to expand the estimated number of CWT chinook in the escapement (from Table 31) to account for unmarked hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (CWT + untagged releases) / CWT releases.

Brood year	CWT release group	Release Numbers		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery		Total	
		CWT	Untagged (c)		M(b)	F	M	F	M	F	M	F
1987	24419	24457	333484	14.64	0.0	0.0	32.1	0.0	44.6	0.0	76.7	0.0
	24420	24386	332520	14.64	0.0	0.0	0.0	0.0	44.6	0.0	44.6	0.0
	24421	24486	333883	14.64	0.0	0.0	0.0	0.0	22.3	0.0	22.3	0.0
	24736	20607	65511	4.18	0.0	0.0	9.2	0.0	12.7	0.0	21.9	0.0
	24737	20607	65511	4.18	0.0	0.0	9.2	0.0	0.0	0.0	9.2	0.0
	25359	24727	310993	13.58	0.0	0.0	0.0	0.0	20.7	0.0	20.7	0.0
	25360	24834	312340	13.58	0.0	0.0	0.0	0.0	41.4	0.0	41.4	0.0
	25361	24504	328819	14.42	0.0	0.0	63.3	0.0	22.0	0.0	85.3	0.0
	25363	24222	51484	3.13	0.0	0.0	13.7	0.0	4.8	0.0	18.5	0.0
	Subtotal				0.0	0.0	127.5	0.0	212.9	0.0	340.5	0.0
1986	24152	19947	276591	14.87	0.0	0.0	130.6	189.2	90.6	95.7	221.1	284.8
	24153	19935	276591	14.87	74.5	0.0	32.7	189.3	158.6	23.9	265.8	213.2
	24154	19990	276591	14.84	74.4	0.0	65.1	62.9	135.6	71.6	275.1	134.5
	24155	18978	467555	25.64	0.0	0.0	112.6	0.0	195.2	123.7	307.8	123.7
	24156	20006	467555	24.37	0.0	0.0	160.5	155.0	185.6	117.6	346.1	272.7
	24157	19982	467555	24.40	0.0	0.0	160.7	103.5	408.8	39.2	569.5	142.7
	24158	19980	299513	15.99	0.0	83.4	105.3	169.6	121.8	205.8	227.1	458.7
	24159	19899	299513	16.05	0.0	0.0	70.5	136.2	171.1	103.3	241.6	239.5
	24160	19979	299513	15.99	0.0	83.4	105.3	101.7	194.9	180.1	300.2	365.2
	Subtotal				148.9	166.8	943.3	1107.4	1662.1	960.9	2754.3	2235.1
1985	23522	19964	318335	16.95	0.0	0.0	0.0	71.9	0.0	0.0	0.0	71.9
	23523	19975	320079	17.02	0.0	0.0	37.4	0.0	0.0	82.2	37.4	82.2
	23524	20127	321701	16.98	170.2	88.6	37.3	144.1	0.0	0.0	207.5	232.6
	23525	20038	273848	14.67	0.0	0.0	0.0	62.2	0.0	0.0	0.0	62.2
	23554	20110	274832	14.67	0.0	76.5	0.0	124.4	0.0	47.2	0.0	248.1

Table 33. Estimates of total escapement of hatchery reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The expansion factor is used to expand the estimated number of CWT chinook in the escapement (from Table 31) to account for unmarked hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (CWT + untagged releases) / CWT releases.

Brood year	CWT release group	Release Numbers		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery		Total	
		CWT	Untagged (c)		M(b)	F	M	F	M	F	M	F
	23555	20096	274640	14.67	0.0	153.0	32.2	155.5	0.0	0.0	32.2	308.5
	23556	20145	284309	15.11	75.7	78.8	33.2	192.3	0.0	0.0	108.9	271.1
	23557	20110	283815	15.11	0.0	0.0	33.2	96.2	0.0	24.3	33.2	120.5
	23558	20096	283618	15.11	75.7	157.6	99.5	224.4	0.0	48.6	175.3	430.6
	23645	24843	98507	4.97	0.0	51.8	21.8	42.1	0.0	8.0	21.8	101.9
	Subtotal				321.7	606.2	294.6	1113.0	0.0	210.3	616.3	1929.5
1984	23322	24584	316880	13.89	0.0	0.0	0.0	0.0	0.0	22.3	0.0	22.3
	23323	24538	316288	13.89	0.0	0.0	0.0	29.5	0.0	0.0	0.0	29.5
	23324	24527	316145	13.89	0.0	72.4	0.0	29.5	0.0	0.0	0.0	101.9
	23325	26157	305357	12.67	0.0	66.1	0.0	0.0	0.0	0.0	0.0	66.1
	23326	24937	291114	12.67	0.0	0.0	0.0	0.0	0.0	20.4	0.0	20.4
	23329	29676	369721	13.46	0.0	0.0	0.0	85.6	0.0	0.0	0.0	85.6
	23330	24459	314724	13.87	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	82352	10317	543	1.05	0.0	0.0	0.0	6.7	0.0	0.0	0.0	6.7
	82354	10228	595	1.06	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	82355	10073	586	1.06	0.0	0.0	0.0	2.2	0.0	0.0	0.0	2.2
	82356	9940	579	1.06	0.0	0.0	2.3	0.0	0.0	0.0	2.3	0.0
	Subtotal				5.3	138.5	2.3	153.5	0.0	42.7	7.6	334.7
Total hatchery					475.9	911.6	1240.2	2373.8	1662.1	1213.9	3378.3	4499.3
Strays: (d)												
1986	24703	26423	0	1.00	0.0	5.2	0.0	0.0	0.0	0.0	0.0	5.2
1986	24704	24567	0	1.00	5.0	5.2	0.0	0.0	0.0	0.0	5.0	5.2
1985	24104	49247	801	1.02	0.0	10.6	0.0	0.0	0.0	0.0	0.0	10.6

Table 33. Estimates of total escapement of hatchery reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1990. The expansion factor is used to expand the estimated number of CWT chinook in the escapement (from Table 31) to account for unmarked hatchery releases and hence to derive hatchery contributions to escapement. Expansion factor = (CWT + untagged releases) / CWT releases.

Brood year	CWT release group	Release Numbers		Expansion Factor	Expanded hatchery contribution (a)							
					Campbell River		Quinsam River		Quinsam Hatchery		Total	
		CWT	Untagged (c)		M(b)	F	M	F	M	F	M	F
Total strays					5.0	21.0	0.0	0.0	0.0	0.0	5.0	21.0

(a) Abbreviations are M= male and F = female

(b) Includes jacks

(c) Untagged = AD only (i.e. tag lost) + unmarked (i.e. no CWT/AFC applied)

(d) CWT fish that have strayed to the system from other enhancement facilities

Table 34. Estimated hatchery and stray contributions to Campbell River, Quinsam River and Quinsam Hatchery chinook salmon escapement, 1989. Contributions were calculated using expansion Method B for the estimated number of CWTs (Table 32).

				Hatchery contribution (b)				Stray contribution (b)			
		Estimated escapement (a)		Male		Female		Male		Female	
Area	Age	Male (c)	Female	Number	%	Number	%	Number	%	Number	%
Campbell River											
	2.1	0	0	0		0		0		0	
	3.1	85	0	45	52.9	0		3	3.5	0	
	4.1	222	81	84	37.8	60	74.1	6	2.7	3	3.7
	5.1	639	1135	454	71.0	505	44.5	0	0.0	0	0.0
	6.1	7	18	0	0.0	0	0.0	0	0.0	0	0.0
	Total	953	1234	583	61.2	565	45.8	9	0.9	3	0.2
Quinsam River											
	2.1	0	0	25		0		0		0	
	3.1	947	0	772	81.5	0		0	0.0	0	
	4.1	641	398	637	99.4	314	78.9	0	0.0	0	0.0
	5.1	1668	2847	1240	74.3	2521	88.5	0	0.0	0	0.0
	6.1	0	16	0		2	12.5	0		0	0.0
	Total	3256	3261	2649	81.4	2837	87.0	0	0.0	0	0.0
Quinsam Hatchery (d)											
	2.1	22	0	17	77.3	0		0	0.0	0	
	3.1	1649	68	1938	100.0 (e)	80	100.0 (e)	0	0.0	0	0.0
	4.1	893	326	500	56.0	76	23.3	0	0.0	0	0.0
	5.1	1125	2034	548	48.7	2004	98.5	0	0.0	0	0.0
	6.1	0	5	0		0	0.0	0		0	0.0
	Total	3689	2433	3003	81.4	2160	88.8	0	0.0	0	0.0

(a) From Table 17
(b) From Table 32
(c) Includes jacks
(d) Hatchery estimates consist of rack recoveries and fish passed above the fence or fence swim throughs
(e) Estimated hatchery contribution greater than 100%

Table 35. Estimated hatchery and stray contributions to Campbell River, Quinsam River and Quinsam Hatchery chinook salmon escapement, 1990. Contributions were calculated using expansion Method B for the estimated number of CWTs (Table 33).

				Hatchery contribution (b)				Stray contribution (b)			
		Estimated escapement (a)		Male		Female		Male		Female	
Area	Age	Male (c)	Female	Number	%	Number	%	Number	%	Number	%
Campbell River											
	3.1	71	9	0	0.0	0	0.0	0	0.0	0	0.0
	4.1	875	484	149	17.0	167	34.5	5	0.6	10	2.1
	5.1	682	994	322	47.2	606	61.0	0	0.0	11	1.1
	6.1	71	260	5	7.0	139	53.5	0	0.0	0	0.0
	Total	1699	1747	476	28.0	912	52.2	5	0.3	21	1.2
Quinsam River											
	2.1	34	0	0	0.0	0		0	0.0	0	
	3.1	123	0	128	100 (d)	0		0	0.0	0	
	4.1	1833	1924	943	51.4	1107	57.5	0	0.0	0	0.0
	5.1	839	1626	295	35.2	1113	68.5	0	0.0	0	0.0
	6.1	34	267	2	5.9	153	57.3	0	0.0	0	0.0
	Total	2829	3817	1368	48.4	2373	62.2	0	0.0	0	0.0
Quinsam Hatchery											
	2.1	33	0	0	0.0	0		0	0.0	0	
	3.1	300	7	213	71.0	0	0.0	0	0.0	0	0.0
	4.1	2597	2135	1662	64.0	961	45.0	0	0.0	0	0.0
	5.1	69	249	0	0.0	210	84.3	0	0.0	0	0.0
	6.1	0	22	0		43	100 (d)	0		0	0.0
	Total	2999	2413	1875	62.5	1214	50.3	0	0.0	0	0.0

(a) From Table 18
(b) From Table 33
(c) Includes jacks
(d) Estimated hatchery contribution greater than 100%

APPENDIX A

Appendix A1. Staple tagging of chinook salmon carcasses in Campbell River, 1989.

Date	Capture area (a)	Tagged			
		Males	Females	Jacks	Total
Oct-17	1A	2	0	0	2
	1B	5	1	0	6
Oct-19	1A	1	1	0	2
	1B	10	6	0	16
Oct-24	1A	2	1	0	3
	1B	6	15	0	21
Oct-25	1A	0	0	0	0
	1B	1	9	0	10
Oct-26	1A	1	1	0	2
	1B	15	28	0	43
Oct-27	1A	3	1	0	4
	1B	9	4	0	13
Oct-31	1A	0	2	0	2
	1B	14	53	0	67
Nov-01	1A	1	5	0	6
	1B	0	0	0	0
Nov-02	1A	0	0	0	0
	1B	5	7	0	12
Nov-03	1A	1	1	0	2
	1B	12	15	0	27
Nov-07	1A	0	2	0	2
	1B	10	25	1	36
Nov-08	1A	0	1	0	1
	1B	1	3	0	4
Nov-09	1A	0	0	0	0
	1B	2	7	0	9
Nov-14	1A	0	0	0	0
	1B	10	19	0	29
Nov-15	1A	1	2	0	3
	1B	11	32	0	43
Nov-17	1A	0	0	0	0
	1B	4	10	0	14
Nov-21	1A	0	1	0	1
	1B	4	4	0	8
Nov-22	1A	0	2	0	2
	1B	0	1	0	1
	Total	131	259	1	391

(a) See Fig.1 for location of capture areas

Appendix A2. Staple tagging of chinook salmon carcasses in Quinsam River, 1989.

Date	Capture area (a)	Tagged Males	Females	Jacks	Total	Date	Capture area (a)	Tagged Males	Females	Jacks	Total
Oct-16	2B	0	0	0	0	Nov-13	2B	19	31	0	50
	2C	5	2	0	7		2C	46	45	0	91
	2D	4	1	0	5		2D	0	0	0	0
Oct-18	2B	2	0	0	2	Nov-14	2B	0	0	0	0
	2C	1	3	0	4		2C	15	21	0	36
	2D	0	2	0	2		2D	0	0	0	0
Oct-23	2B	2	2	0	4	Nov-15	2B	0	0	0	0
	2C	1	3	0	4		2C	0	1	0	1
	2D	1	8	0	9		2D	22	43	0	65
Oct-25	2B	6	5	0	11	Nov-16	2B	8	23	0	31
	2C	11	11	0	22		2C	16	40	1	57
	2D	7	10	0	17		2D	2	2	0	4
Oct-30	2B	7	20	0	27	Nov-17	2B	0	0	0	0
	2C	36	68	0	104		2C	0	0	0	0
	2D	7	9	0	16		2D	18	25	0	43
Oct-31	2B	0	0	0	0	Nov-20	2B	8	25	0	33
	2C	0	0	0	0		2C	27	44	0	71
	2D	9	14	0	23		2D	12	7	0	19
Nov-01	2B	26	46	0	72	Nov-21	2B	0	0	0	0
	2C	48	44	3	95		2C	1	8	0	9
	2D	11	15	0	26		2D	0	0	0	0
Nov-03	2B	0	0	0	0	Nov-23	2B	7	12	0	19
	2C	23	49	0	72		2C	6	13	0	19
	2D	0	0	0	0		2D	8	7	0	15
Nov-06	2B	49	87	1	137	Nov-24	2B	0	0	0	0
	2C	45	92	0	137		2C	11	28	0	39
	2D	13	38	0	51		2D	0	0	0	0
Nov-07	2B	0	0	0	0	Nov-27	2B	0	0	0	0
	2C	15	27	0	42		2C	10	8	0	18
	2D	0	0	0	0		2D	0	3	0	3
Nov-08	2B	7	16	1	24	Nov-28	2B	1	4	0	5
	2C	17	46	0	63		2C	11	3	0	14
	2D	13	23	0	36		2D	0	0	0	0
Nov-09	2B	8	8	0	16	Nov-29	2B	0	0	0	0
	2C	0	2	0	2		2C	0	0	0	0
	2D	0	0	0	0		2D	8	11	0	19
Nov-10	2B	0	0	0	0	Nov-30	2B	3	3	0	6
	2C	17	31	0	48		2C	6	9	0	15
	2D	4	8	0	12		2D	0	0	0	0
							Total	660	1106	6	1772

(a) See Fig.1 for location of capture areas

Appendix A3. Summary of release of live-tagged chinook salmon carcasses in Campbell and Quinsam rivers, 1989. Tagging was conducted near Bob's Boathouse in the Campbell River estuary (a). The data is partitioned into 3 two week periods.

Tagging Date	Males	Females	Jacks	Total
Aug-23	14	22	1	37
Aug-24	44	38	2	84
Aug-25	19	23	5	47
Aug-30	53	43	10	106
Total	130	126	18	274
Sep-05	7	10	1	18
Sep-07	14	2	1	17
Total	21	12	2	35
Sep-15	0	3	0	3
Sep-19	19	33	5	57
Sep-20	7	14	1	22
Total	26	50	6	82
Sep-25	0	1	0	1
Sep-27	0	1	0	1
Sep-28	2	0	0	2
Total	2	2	0	4
Oct-06	6	12	2	20
Total	6	12	2	20
Oct-11	9	7	0	16
Oct-13	31	30	0	61
Oct-16	1	0	0	1
Total	41	37	0	78
Grand total	226	239	28	493

(a) See Fig. 1 for location of Bob's Boathouse.

Appendix A4. Dead recovery of tagged chinook salmon carcasses in Campbell River, 1989.

Date	Recovery area (a)	Recovered			
		Males	Females	Jacks	Total
Oct-19	1A	2	0	0	2
	1B	1	0	0	1
Oct-24	1A	1	1	0	2
	1B	1	0	0	1
Oct-26	1A	0	0	0	0
	1B	3	10	0	13
Oct-27	1A	1	1	0	2
	1B	2	1	0	3
Oct-31	1A	1	1	0	2
	1B	7	10	0	17
Nov-01	1A	2	0	0	2
	1B	0	0	0	0
Nov-02	1A	0	0	0	0
	1B	2	3	0	5
Nov-03	1A	0	0	0	0
	1B	4	19	0	23
Nov-07	1A	0	2	0	2
	1B	2	7	0	9
Nov-08	1A	0	0	0	0
	1B	1	7	0	8
Nov-09	1A	0	0	0	0
	1B	3	0	0	3
Nov-11	1A	0	0	0	0
	1B	0	1	0	1
Nov-14	1A	0	0	0	0
	1B	2	14	0	16
Nov-15	1A	0	1	0	1
	1B	3	9	0	12
Nov-17	1A	0	0	0	0
	1B	2	9	0	11
Nov-21	1A	0	0	0	0
	1B	4	9	0	13
Nov-22	1A	0	1	0	1
	1B	6	5	0	11
Nov-23	1A	0	0	0	0
	1B	1	0	0	1
Nov-24	1A	0	0	0	0
	1B	3	6	0	9
	Total	54	117	0	171

(a) See Fig.1 for location of recovery areas

Appendix A5. Dead recovery of chinook salmon carcasses in Quinsam River, 1989.

Date	Recovery area (a)	Recovered				Date	Recovery area (a)	Recovered			
		Males	Females	Jacks	Total			Males	Females	Jacks	Total
Oct-18	2B	0	0	0	0	Nov-14	2B	0	0	0	0
	2C	1	2	0	3		2C	12	28	0	40
	2D	1	0	0	1		2D	0	0	0	0
Oct-23	2B	0	2	0	2	Nov-15	2B	0	0	0	0
	2C	1	1	0	2		2C	0	0	0	0
	2D	0	1	0	1		2D	11	25	0	36
Oct-25	2B	0	1	0	1	Nov-16	2B	11	15	0	26
	2C	1	2	0	3		2C	22	34	0	56
	2D	1	3	0	4		2D	6	13	0	19
Oct-30	2B	3	0	0	3	Nov-17	2B	0	0	0	0
	2C	1	7	0	8		2C	0	0	0	0
	2D	1	1	0	2		2D	9	42	0	51
Oct-31	2B	0	0	0	0	Nov-20	2B	2	6	0	8
	2C	0	0	0	0		2C	10	38	0	48
	2D	3	5	0	8		2D	11	13	0	24
Nov-01	2B	4	15	0	19	Nov-21	2B	0	0	0	0
	2C	23	46	0	69		2C	2	4	0	6
	2D	18	18	0	36		2D	0	0	0	0
Nov-03	2B	0	0	0	0	Nov-23	2B	2	10	0	12
	2C	5	14	0	19		2C	21	21	0	42
	2D	0	0	0	0		2D	9	15	0	24
Nov-06	2B	17	32	0	49	Nov-24	2B	0	0	0	0
	2C	12	28	0	40		2C	23	20	0	43
	2D	3	7	0	10		2D	0	0	0	0
Nov-07	2B	0	0	0	0	Nov-27	2B	2	5	0	7
	2C	19	20	0	39		2C	4	9	0	13
	2D	0	0	0	0		2D	8	3	0	11
Nov-08	2B	6	14	0	20	Nov-28	2B	0	3	0	3
	2C	15	60	0	75		2C	7	7	0	14
	2D	22	41	0	63		2D	0	0	0	0
Nov-09	2B	4	2	0	6	Nov-29	2B	0	0	0	0
	2C	0	0	0	0		2C	0	0	0	0
	2D	0	0	0	0		2D	11	18	0	29
Nov-10	2B	0	0	0	0	Nov-30	2B	1	5	0	6
	2C	17	19	0	36		2C	23	25	0	48
	2D	4	2	0	6		2D	0	0	0	0
Nov-13	2B	7	6	0	13						
	2C	9	41	0	50		Total	405	749	0	1154
	2D	0	0	0	0						

(a) See Fig.1 for location of recovery areas

Appendix A6. Sequential mark-recapture data for chinook salmon carcasses in Campbell River, 1989. Carcasses examined on or before the first date of tagging are not included in the number examined for the mark-recapture estimate (MR). Numbers in bold are incorrect and underestimate the true number of fish examined (could not be verified).

Date	Males			Females			Jacks			Total		
	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries
Oct-17	13	7	0	6	1	0	0	0	0	19	8	0
Oct-19	24	11	3	14	7	0	0	0	0	38	18	3
Oct-24	25	8	2	32	16	1	0	0	0	57	24	3
Oct-25	11	1	0	10	9	0	0	0	0	21	10	0
Oct-26	54	16	3	44	29	10	0	0	0	98	45	13
Oct-27	22	12	3	14	5	2	0	0	0	36	17	5
Oct-31	44	14	8	112	55	11	0	0	0	156	69	19
Nov-01	4	1	2	5	5	0	0	0	0	9	6	2
Nov-02	10	5	2	12	7	3	0	0	0	22	12	5
Nov-03	26	13	4	27	16	19	0	0	0	53	29	23
Nov-07	25	10	2	43	27	9	2	1	0	70	38	11
Nov-08	3	1	1	14	4	7	0	0	0	17	5	8
Nov-09	7	2	3	14	7	0	0	0	0	21	9	3
Nov-11			0			1			0		0	1
Nov-14	31	10	2	50	19	14	0	0	0	81	29	16
Nov-15	24	12	3	48	34	10	0	0	0	72	46	13
Nov-17	8	4	2	22	10	9	0	0	0	30	14	11
Nov-21	11	4	4	9	5	9	0	0	0	20	9	13
Nov-22	3	0	6	7	3	6	0	0	0	10	3	12
Nov-23	3	0	1	2	0	0	0	0	0	5	0	1
Nov-24	8	0	3	20	0	6	0	0	0	28	0	9
Totals	356	131	54	505	259	117	2	1	0	863	391	171
Totals for MR(a)	343	131	54	499	259	117	2	1	0	844	391	171

(a) To be used in the Petersen population estimation procedure for the carcass tagging and recovery method; the larger totals are to be used for the live tagging and recovery method.

Appendix A7. Sequential mark-recapture data for chinook salmon carcasses in Quinsam River, 1989. Carcasses examined on or before the first date of tagging are not included in the number examined for the mark-recapture estimate (MR). Numbers in bold are incorrect and underestimate the true number of fish examined (could not be verified).

Date	Males			Females			Jacks			Total		
	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries
Oct-16	19	9	0	8	3	0	0	0	0	27	12	0
Oct-18	12	3	2	7	5	2	1	0	0	20	8	4
Oct-23	19	4	1	19	13	4	1	0	0	39	17	5
Oct-25	57	24	2	45	26	6	1	1	0	103	51	8
Oct-30	152	50	5	177	97	8	3	0	0	332	147	13
Oct-31	24	9	3	28	14	5	0	0	0	52	23	8
Nov-01	225	85	45	209	105	79	12	3	0	446	193	124
Nov-03	75	23	5	97	49	14	3	0	0	175	72	19
Nov-06	292	107	32	413	217	67	3	1	0	708	325	99
Nov-07	61	15	19	41	27	20	0	0	0	102	42	39
Nov-08	94	37	43	177	85	115	3	1	0	274	123	158
Nov-09	23	8	4	18	10	2	0	0	0	41	18	6
Nov-10	58	21	21	66	39	21	5	0	0	129	60	42
Nov-13	138	65	16	157	76	47	4	0	0	299	141	63
Nov-14	33	15	12	**39**	**21**	**28**	2	0	0	**74**	**36**	**40**
Nov-15	56	22	11	103	44	25	1	0	0	160	66	36
Nov-16	82	26	39	129	65	62	1	0	0	212	91	101
Nov-17	49	18	9	68	25	42	2	0	0	119	43	51
Nov-20	123	47	23	147	76	57	1	0	0	271	123	80
Nov-21	7	1	2	25	8	4	1	0	0	33	9	6
Nov-23	85	21	32	96	32	46	0	0	0	181	53	78
Nov-24	41	11	23	62	28	20	0	0	0	103	39	43
Nov-27	20	10	14	**27**	**11**	**17**	0	0	0	**47**	**21**	**31**
Nov-28	57	12	7	41	7	10	0	0	0	98	19	17
Nov-29	27	8	11	35	11	18	0	0	0	62	19	29
Nov-30	50	9	24	46	12	30	0	0	0	96	21	54
Totals	1879	660	405	2280	1106	749	44	6	0	4203	1772	1154
Totals for MR (a)	1860	660	405	2272	1106	749	44	6	0	4176	1772	1154

(a) To be used in the Petersen population estimation procedure for the carcass tagging and recovery method; the larger totals are to be used for the live tagging and recovery method.

Appendix A8. Summary of recovery of live-tagged chinook salmon carcasses in Campbell River, 1989.

Tagging period	Recovery date	Males	Females	Jacks	Total
Aug23 - Sep 8	Oct-19	0	1	0	1
	Oct-24	1	0	0	1
	Oct-25	0	0	0	0
	Oct-26	2	0	0	2
	Oct-27	1	0	0	1
	Oct-31	0	0	0	0
	Nov-02	0	1	0	1
	Nov-03	0	1	0	1
	Nov-15	0	0	0	0
	Nov-21	1	0	0	1
Sep 15 - 30	Oct-19	0	0	0	0
	Oct-24	0	0	0	0
	Oct-25	0	0	0	0
	Oct-26	0	0	0	0
	Oct-27	0	0	0	0
	Oct-31	0	0	0	0
	Nov-02	0	0	0	0
	Nov-03	0	0	0	0
	Nov-15	1	0	0	1
	Nov-21	0	0	0	0
Oct 6 - 16	Oct-19	1	0	0	1
	Oct-24	0	0	0	0
	Oct-25	0	1	0	1
	Oct-26	0	0	0	0
	Oct-27	0	0	0	0
	Oct-31	0	1	0	1
	Nov-02	0	0	0	0
	Nov-03	0	0	0	0
	Nov-15	1	0	0	1
	Nov-21	0	0	0	0
Total		8	5	0	13

Appendix A9. Summary of recovery of live-tagged chinook salmon carcasses in Quinsam River, 1989.

Tagging period	Recovery date	Males	Females	Jacks	Total
Aug23 - Sep 8	Oct-16	1	0	0	1
	Oct-18	0	0	0	0
	Oct-25	0	1	0	1
	Oct-30	2	2	0	4
	Nov-01	3	0	0	3
	Nov-03	1	1	0	2
	Nov-06	4	2	0	6
	Nov-08	0	1	0	1
	Nov-10	0	1	0	1
	Nov-13	0	1	0	1
	Nov-14	0	0	0	0
	Nov-16	1	3	0	4
	Nov-17	0	0	0	0
	Nov-20	0	2	0	2
	Nov-24	0	0	0	0
	Nov-27	1	0	0	1
	Nov-28	1	1	0	2
	Nov-29	1	0	0	1
Sep 15 - 30	Oct-16	0	0	0	0
	Oct-18	0	0	0	0
	Oct-25	0	0	0	0
	Oct-30	1	0	0	1
	Nov-01	2	0	0	2
	Nov-03	0	0	0	0
	Nov-06	1	1	0	2
	Nov-08	0	0	0	0
	Nov-10	0	0	0	0
	Nov-13	0	1	0	1
	Nov-14	0	0	0	0
	Nov-16	1	3	0	4
	Nov-17	0	0	0	0
	Nov-20	0	0	0	0
	Nov-24	0	1	0	1
	Nov-27	0	0	0	0
	Nov-28	0	0	0	0
	Nov-29	0	0	0	0
Oct 6 - 16	Oct-16	0	0	0	0
	Oct-18	0	2	0	2
	Oct-25	0	0	0	0
	Oct-30	0	1	0	1
	Nov-01	0	0	0	0
	Nov-03	0	0	0	0

Appendix A9. Summary of recovery of live-tagged chinook salmon carcasses in Quinsam River, 1989.

Tagging period	Recovery date	Males	Females	Jacks	Total
	Nov-06	0	2	0	2
	Nov-08	0	0	0	0
	Nov-10	0	0	0	0
	Nov-13	1	0	0	1
	Nov-14	0	0	0	0
	Nov-16	0	0	0	0
	Nov-17	1	0	0	1
	Nov-20	0	0	0	0
	Nov-24	0	0	0	0
	Nov-27	0	0	0	0
	Nov-28	0	0	0	0
	Nov-29	0	0	0	0
Total		22	26	0	48

Appendix A10. Summary of recovery of live-tagged chinook salmon carcasses at Quinsam Hatchery rack, 1989.

Tagging period	Recovery date	Males	Females	Jacks	Total
Aug23 - Sep 8	Oct-12	2	1	1	4
	Oct-13	0	2	0	2
	Oct-16	1	0	0	1
	Oct-17	6	2	0	8
	Oct-18	0	4	0	4
	Oct-19	0	1	0	1
	Oct-20	8	2	0	10
	Oct-23	3	3	0	6
	Oct-24	5	0	0	5
	Oct-25	0	1	0	1
	Oct-26	3	0	0	3
	Oct-27	3	0	0	3
	Oct-29	2	0	0	2
	Oct-30	0	2	0	2
	Oct-31	3	0	0	3
	Nov-01	3	1	0	4
	Nov-02	2	1	0	3
	Nov-03	2	0	0	2
Sep 15 - 30	Oct-12	0	0	0	0
	Oct-13	0	0	0	0
	Oct-16	0	0	0	0
	Oct-17	2	0	0	2
	Oct-18	0	0	0	0
	Oct-19	0	1	0	1
	Oct-20	0	0	0	0
	Oct-23	0	0	0	0
	Oct-24	1	0	0	1
	Oct-25	0	0	0	0
	Oct-26	1	0	0	1
	Oct-27	1	0	0	1
	Oct-29	3	0	0	3
	Oct-30	0	0	0	0
	Oct-31	2	0	0	2
	Nov-01	0	1	0	1
	Nov-02	0	0	0	0
	Nov-03	0	0	0	0
Oct 6 - 16	Oct-12	0	0	0	0
	Oct-13	0	0	0	0
	Oct-16	0	0	0	0
	Oct-17	1	0	0	1
	Oct-18	0	0	0	0
	Oct-19	0	1	0	1

Appendix A10. Summary of recovery of live-tagged chinook salmon carcasses at Quinsam Hatchery rack, 1989.

Tagging period	Recovery date	Males	Females	Jacks	Total
	Oct-20	2	0	0	2
	Oct-23	2	0	0	2
	Oct-24	0	0	0	0
	Oct-25	0	3	0	3
	Oct-26	0	0	0	0
	Oct-27	1	1	0	2
	Oct-29	0	0	0	0
	Oct-30	0	1	0	1
	Oct-31	3	0	0	3
	Nov-01	0	0	0	0
	Nov-02	0	1	0	1
	Nov-03	0	0	0	0
Total		62	29	1	92

Appendix A11. Total dead recovery and adipose clip recovery of chinook salmon in Campbell River, 1989 (a).

	Area 1A								Area 1B							
	Total recovered (b)				Adipose clipped recovered				Total recovered (b)				Adipose clipped recovered			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
Oct-17	2	2	0	4	0	0	0	0	11	4	0	15	0	1	0	1
Oct-19	1	4	0	5	0	0	0	0	23	10	0	33	1	0	0	1
Oct-24	4	2	0	6	0	3	0	3	21	30	0	51	2	3	0	5
Oct-25	0	0	0	0	0	0	0	0	11	10	0	21	1	0	0	1
Oct-26	3	1	0	4	0	0	0	0	51	43	0	94	3	4	0	7
Oct-27	5	3	0	8	0	0	0	0	17	11	0	28	1	0	0	1
Oct-31	1	3	0	4	0	0	0	0	43	109	0	152	5	8	0	13
Nov-01	4	5	0	9	0	1	0	1	0	0	0	0	0	0	0	0
Nov-02	1	2	0	3	0	0	0	0	9	10	0	19	0	2	0	2
Nov-03	0	0	0	0	0	0	0	0	26	27	0	53	0	2	0	2
Nov-07	7	5	1	13	5	3	0	8	18	38	1	57	0	0	0	0
Nov-08	2	3	0	5	0	1	0	1	1	11	0	12	0	0	0	0
Nov-09	0	0	0	0	0	0	0	0	7	14	0	21	0	2	0	2
Nov-14	3	0	0	3	0	0	0	0	28	50	0	78	1	2	0	3
Nov-15	3	2	0	5	0	0	0	0	21	46	0	67	3	2	0	5
Nov-17	0	0	0	0	0	0	0	0	8	22	0	30	0	3	0	3
Nov-21	1	1	0	2	0	0	0	0	10	8	0	18	0	1	0	1
Nov-22	0	3	0	3	0	0	0	0	3	4	0	7	1	0	0	1
Nov-23	0	0	0	0	0	0	0	0	3	2	0	5	0	0	0	0
Nov-24	0	0	0	0	0	0	0	0	8	20	0	28	2	2	0	4
Total	37	36	1	74	5	8	0	13	319	469	1	789	20	32	0	52

(a) See Fig. 1 for location of recovery areas

(b) Abbreviations are M=male, F=female, J=jack, T=total

Appendix A12. Total dead recovery and adipose clip recovery of chinook salmon in Quinsam River, 1989 (a).

	Area 2B								Area 2C								Area 2C							
	Total recovered (b)				Adipose clipped recovered				Total recovered (b)				Adipose clipped recovered				Total recovered (b)				Adipose clipped recovered			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
Oct-16	1	0	0	1	0	0	0	0	11	3	0	14	0	0	0	0	7	5	0	12	2	1	0	3
Oct-18	5	0	1	6	1	0	0	1	6	5	0	11	0	0	0	0	1	2	0	3	0	0	0	0
Oct-23	7	3	0	10	0	0	0	0	3	5	0	8	0	0	0	0	9	11	1	21	2	1	0	3
Oct-25	9	13	1	23	0	0	0	0	31	17	0	48	0	0	0	0	17	15	0	32	0	1	0	1
Oct-30	34	29	0	63	3	4	0	7	100	128	3	231	7	8	0	15	18	20	0	38	2	3	0	5
Oct-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	28	0	52	1	4	0	5
Nov-01	40	45	0	85	2	6	0	8	123	84	10	217	4	13	0	17	62	80	2	144	5	10	1	16
Nov-03	0	0	0	0	0	0	0	0	75	97	3	175	6	8	0	14	0	0	0	0	0	4	0	4
Nov-06	125	172	1	298	6	12	0	18	130	163	2	295	13	12	0	25	37	78	0	115	2	5	0	7
Nov-07	0	0	0	0	0	0	0	0	61	41	0	102	3	3	0	6	0	0	0	0	0	0	0	0
Nov-08	16	23	1	40	2	5	0	7	53	93	0	146	4	6	0	10	25	61	2	88	3	6	0	9
Nov-09	21	15	0	36	3	3	0	6	2	3	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Nov-10	0	0	0	0	0	0	0	0	52	49	4	105	6	3	0	9	6	17	1	24	1	2	0	3
Nov-13	44	62	1	107	1	5	0	6	94	95	3	192	7	9	0	16	0	0	0	0	0	0	0	0
Nov-14	0	0	0	0	0	0	0	0	33	39	2	74	2	2	0	4	0	0	0	0	0	0	0	0
Nov-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	103	1	160	4	15	0	19
Nov-16	34	43	0	77	3	2	0	5	44	79	1	124	6	10	0	16	4	7	0	11	0	2	0	2
Nov-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	68	2	119	7	10	0	17
Nov-20	27	39	0	66	3	0	0	3	66	89	1	156	7	13	0	20	30	19	0	49	3	5	0	8
Nov-21	0	1	0	1	0	1	0	1	7	24	1	32	1	4	0	5	0	0	0	0	0	0	0	0
Nov-23	16	21	0	37	0	1	0	1	51	55	0	106	6	3	0	9	18	20	0	38	4	2	0	6
Nov-24	0	0	0	0	0	0	0	0	41	62	0	103	5	4	0	9	0	0	0	0	0	0	0	0
Nov-27	7	14	0	21	1	2	0	3	9	8	0	17	4	1	0	5	4	5	0	9	0	2	0	2
Nov-28	5	8	0	13	2	2	0	4	52	33	0	85	1	4	0	5	0	0	0	0	0	0	0	0
Nov-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	35	0	62	2	4	0	6
Nov-30	48	44	0	92	0	0	0	0	2	2	0	4	2	2	0	4	0	0	0	0	0	0	0	0
Total	439	532	5	976	27	43	0	70	1046	1174	30	2250	84	105	0	189	394	574	9	977	38	77	1	116

(a) See Fig. 1 for location of recovery areas

Appendix A13. Number of observed adipose clipped chinook salmon to the upper Quinsam River (above the fence) and Quinsam Hatchery rack, by tag code, 1989.

Brood year	CWT code	Upper Quinsam River		Hatchery rack	
		M	F	M	F
1987	24419	0	0	0	0
	24956	0	0	1	0
	Subtotal	0	0	1	0
1986	24152	0	0	15	0
	24153	0	0	10	0
	24154	0	0	11	0
	24155	0	0	3	0
	24156	0	0	6	0
	24157	0	0	15	0
	24158	0	0	3	1
	24159	0	0	17	1
	24160	0	0	15	2
	Subtotal	0	0	95	4
1985	23522	0	0	2	1
	23523	0	0	2	0
	23524	0	0	2	0
	23525	0	0	4	1
	23554	0	0	5	0
	23555	0	0	1	1
	23556	0	0	1	0
	23557	0	0	7	0
	23558	1	0	4	1
	23645	0	0	1	0
	Subtotal	1	0	29	4
1984	23322	0	0	4	9
	23323	0	0	3	12
	23324	0	0	2	8
	23325	0	0	2	18
	23326	1	1	2	18
	23327	2	1	6	17
	23328	2	1	8	14
	23329	0	1	4	14
	23330	0	3	4	10
	82351	2	0	0	4
	82352	0	0	1	1
	82353	0	0	2	1
	82354	0	0	0	1
	82355	0	0	0	0
	82356	0	0	0	3
	82357	0	0	0	2

Appendix A13. Number of observed adipose clipped chinook salmon to the upper Quinsam River (above the fence) and Quinsam Hatchery rack, by tag code, 1989.

Brood year	CWT code	Upper Quinsam River M	Upper Quinsam River F	Hatchery rack M	Hatchery rack F
	82358	1	0	0	1
	82359	0	0	0	1
	82360	0	0	1	1
	82361	0	0	0	0
	82362	0	0	0	3
	Subtotal	8	7	39	138
1983	82259	0	0	0	0
	Subtotal	0	0	0	0
Total hatchery		9	7	164	146
No data (5000)		0	0	2	2
No pin (8000)		0	1	11	19
Lost pin (9000)		0	0	0	0
Observed adipose		9	8	13	21

(a) Abbreviations are M = male and F = female

(b) Includes jacks

APPENDIX B

Appendix B1. Staple tagging of chinook salmon carcasses in Campbell River, 1990.

Date	Capture area (a)	Tagged			
		Males	Females	Jacks	Total
Oct-18	1A	0	0	0	0
	1B	3	1	0	4
Oct-19	1A	2	4	0	6
	1B	1	1	0	2
Oct-23	1A	2	0	0	2
	1B	19	25	1	45
Oct-24	1A	4	3	0	7
	1B	3	6	0	9
Oct-26	1A	1	3	0	4
	1B	13	15	0	28
Oct-30	1A	0	0	0	0
	1B	7	8	0	15
Oct-31	1A	0	0	0	0
	1B	10	16	1	27
Nov-02	1A	2	5	0	7
	1B	11	7	0	18
Nov-06	1A	0	0	0	0
	1B	10	9	1	20
Nov-07	1A	3	10	0	13
	1B	13	16	0	29
Nov-09	1A	0	0	0	0
	1B	3	5	0	8
Nov-20	1A	0	0	0	0
	1B	0	0	0	0
Nov-21	1A	0	0	0	0
	1B	10	17	0	27
	Total	117	151	3	271

(a) See Fig.1 for location of capture areas

Appendix B2. Staple tagging of chinook salmon carcasses in Quinsam River, 1990.

Date	Capture area (a)	Tagged			
		Males	Females	Jacks	Total
Oct-18	2B	3	2	0	5
	2C	3	2	0	5
	2D	0	0	0	0
Oct-22	2B	4	4	0	8
	2C	9	9	0	18
	2D	3	2	0	5
Oct-25	2B	1	1	0	2
	2C	0	3	0	3
	2D	1	2	0	3
Oct-29	2B	4	6	0	10
	2C	6	15	1	22
	2D	3	7	0	10
Nov-01	2B	2	7	0	9
	2C	11	15	0	26
	2D	5	8	0	13
Nov-05	2B	10	19	0	29
	2C	30	47	0	77
	2D	2	0	0	2
Nov-06	2B	0	0	0	0
	2C	9	18	0	27
	2D	11	21	0	32
Nov-08	2B	13	19	0	32
	2C	19	34	0	53
	2D	21	20	0	41
Nov-09	2B	0	0	0	0
	2C	19	34	0	53
	2D	0	0	0	0
Nov-19	2B	7	8	0	15
	2C	22	24	0	46
	2D	3	2	0	5
Nov-20	2B	0	0	0	0
	2C	0	0	0	0
	2D	3	5	0	8
Nov-22	2B	5	6	0	11
	2C	4	8	0	12
	2D	0	0	0	0
	Total	233	348	1	582

(a) See Fig.1 for location of capture areas

Appendix B3. Dead recovery of tagged chinook salmon carcasses in Campbell River, 1990.

Date	Recovery area (a)	Recovered			
		Males	Females	Jacks	Total
Oct-18	1A	0	0	0	0
	1B	0	0	0	0
Oct-19	1A	0	0	0	0
	1B	0	0	0	0
Oct-23	1A	0	0	0	0
	1B	1	0	0	1
Oct-24	1A	3	1	0	4
	1B	0	0	0	0
Oct-26	1A	0	0	0	0
	1B	6	6	0	12
Oct-30	1A	0	0	0	0
	1B	1	0	0	1
Oct-31	1A	0	0	0	0
	1B	2	3	0	5
Nov-02	1A	0	1	0	1
	1B	4	2	0	6
Nov-06	1A	0	0	0	0
	1B	2	0	0	2
Nov-07	1A	0	2	0	2
	1B	2	11	0	13
Nov-09	1A	0	1	0	1
	1B	2	1	0	3
Nov-20	1A	0	0	0	0
	1B	0	0	0	0
Nov-21	1A	0	0	0	0
	1B	6	6	0	12
	Total	29	34	0	63

Appendix B4. Dead recovery of tagged chinook salmon carcasses in Quinsam River, 1990.

Date	Recovery area (a)	Recovered			
		Males	Females	Jacks	Total
Oct-18	2B	0	0	0	0
	2C	0	0	0	0
	2D	0	0	0	0
Oct-22	2B	3	1	0	4
	2C	1	1	0	2
	2D	0	0	0	0
Oct-25	2B	0	0	0	0
	2C	0	0	0	0
	2D	0	1	0	1
Oct-29	2B	0	0	0	0
	2C	0	4	0	4
	2D	0	1	0	1
Nov-01	2B	1	1	0	2
	2C	3	7	0	10
	2D	1	1	0	2
Nov-05	2B	0	4	0	4
	2C	11	18	0	29
	2D	0	0	0	0
Nov-06	2B	0	0	0	0
	2C	1	3	0	4
	2D	5	3	0	8
Nov-08	2B	4	4	0	8
	2C	16	28	0	44
	2D	12	22	0	34
Nov-09	2B	0	0	0	0
	2C	9	20	0	29
	2D	0	0	0	0
Nov-19	2B	0	0	0	0
	2C	2	7	0	9
	2D	1	6	0	7
Nov-20	2B	0	0	0	0
	2C	0	0	0	0
	2D	2	1	0	3
Nov-22	2B	4	9	0	13
	2C	10	9	0	19
	2D	0	1	0	1
	Total	86	152	0	238

Appendix B5. Sequential mark-recapture data for chinook salmon carcasses in Campbell River, 1990. Carcasses examined on or before the first date of tagging are not included in the number examined for the mark-recapture estimate (MR). Numbers in bold are incorrect and underestimate the true number of fish examined (could not be verified).

Date	Males			Females			Jacks			Total		
	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries
Oct-18	8	3	0	2	1	0	0	0	0	10	4	0
Oct-19	13	3	0	10	5	0	0	0	0	23	8	0
Oct-23	51	21	1	43	25	0	2	1	0	96	47	1
Oct-24	17	7	3	14	9	1	2	0	0	33	16	4
Oct-26	39	14	6	30	18	6	0	0	0	69	32	12
Oct-30	16	7	1	15	8	0	0	0	0	31	15	1
Oct-31	36	10	2	29	16	3	2	1	0	67	27	5
Nov-02	29	13	4	38	12	3	1	0	0	68	25	7
Nov-06	23	10	2	29	9	0	1	1	0	53	20	2
Nov-07	28	16	2	45	26	13	3	0	0	76	42	15
Nov-09	9	3	2	10	5	2	0	0	0	19	8	4
Nov-20	4	0	0	5	0	0	0	0	0	9	0	0
Nov-21	55	10	6	65	17	6	0	0	0	120	27	12
Totals	328	117	29	335	151	34	11	3	0	674	271	63
Totals for MR(a)	320	117	29	333	151	34	11	3	0	664	271	63

(a) To be used in the Petersen population estimation procedure for the carcass tagging and recovery method; the larger totals are to be used for the live tagging and recovery method.

Appendix B6. Sequential mark-recapture data for chinook salmon carcasses in Quinsam River, 1990. Carcasses examined on or before the first date of tagging are not included in the number examined for the mark-recapture estimate (MR). Numbers in bold are incorrect and underestimate the true number of fish examined (could not be verified).

Date	Males			Females			Jacks			Total		
	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries	No. examined	No. tags applied	No. recoveries
Oct-18	42	6	0	34	4	0	1	0	0	77	10	0
Oct-22	88	16	4	81	15	2	5	0	0	174	31	6
Oct-25	19	2	0	24	6	1	1	0	0	44	8	1
Oct-29	74	13	0	140	28	5	1	1	0	215	42	5
Nov-01	95	18	5	155	30	9	1	0	0	251	48	14
Nov-05	215	42	11	349	66	22	2	0	0	566	108	33
Nov-06	105	20	6	204	39	6	2	0	0	311	59	12
Nov-08	268	53	32	377	73	54	7	0	0	652	126	86
Nov-09	102	19	9	186	34	20	5	0	0	293	53	29
Nov-19	185	32	3	206	34	13	0	0	0	391	66	16
Nov-20	17	3	2	18	5	1	0	0	0	35	8	3
Nov-22	69	9	14	96	14	19	0	0	0	165	23	33
Totals	1279	233	86	1870	348	152	25	1	0	3174	582	238
Totals for MR(a)	1237	233	86	1836	348	152	24	1	0	3097	582	238

(a) To be used in the Petersen population estimation procedure for the carcass tagging and recovery method; the larger totals are to be used for the live tagging and recovery method.

Appendix B7. Total dead recovery and adipose clip recovery of chinook salmon in Campbell River, 1990 (a).

	Area 1A								Area 1B							
	Total recovered (b)				Adipose clipped recovered				Total recovered (b)				Adipose clipped recovered			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
Oct-18	0	0	0	0	0	0	0	0	8	2	0	10	0	1	0	1
Oct-19	7	8	0	15	0	1	0	1	6	2	0	8	0	0	0	0
Oct-23	5	1	0	6	1	0	0	1	46	42	2	90	0	0	0	0
Oct-24	9	6	2	17	0	1	0	1	8	8	0	16	0	0	0	0
Oct-26	4	4	0	8	0	0	0	0	35	26	0	61	0	2	0	2
Oct-30	0	0	0	0	0	0	0	0	16	15	0	31	0	1	0	1
Oct-31	3	2	0	5	0	1	0	1	33	27	2	62	3	2	0	5
Nov-02	5	12	0	17	0	1	0	1	24	26	1	51	0	4	0	4
Nov-06	0	0	0	0	0	0	0	0	23	29	1	53	2	1	0	3
Nov-07	7	22	0	29	0	1	0	1	21	23	3	47	0	0	0	0
Nov-09	0	2	0	2	0	1	0	1	9	8	0	17	0	0	0	0
Nov-20	0	0	0	0	0	0	0	0	4	5	0	9	0	0	0	0
Nov-21	0	0	0	0	0	0	0	0	55	65	0	120	2	1	0	3
Total	40	57	2	99	1	6	0	7	288	278	9	575	7	12	0	19

(a) See Fig. 1 for location of recovery areas

(b) Abbreviations are M=male, F=female, J=jack, T=total

Appendix B8. Total dead recovery and adipose clip recovery of chinook salmon in Quinsam River, 1990 (a).

	Area 2B								Area 2C								Area 2C							
	Total recovered (b)				Adipose clipped recovered				Total recovered (b)				Adipose clipped recovered				Total recovered (b)				Adipose clipped recovered			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
Oct-18	10	9	1	20	0	0	0	0	24	20	0	44	1	0	0	1	8	5	0	13	0	0	0	0
Oct-22	21	17	0	38	1	0	0	1	52	49	1	102	2	1	0	3	15	15	4	34	0	1	0	1
Oct-25	2	6	0	8	0	0	0	0	8	10	1	19	0	0	0	0	9	8	0	17	1	0	0	1
Oct-29	15	31	0	46	0	3	0	3	40	79	1	120	4	4	0	8	19	30	0	49	2	0	0	2
Oct-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov-01	17	37	0	54	2	0	0	2	59	87	0	146	3	7	0	10	19	31	1	51	0	0	0	0
Nov-05	45	89	0	134	2	3	0	5	162	260	1	423	3	15	0	18	8	0	1	9	0	0	0	0
Nov-06	0	0	0	0	0	0	0	0	46	93	0	139	1	2	0	3	59	111	2	172	4	6	0	10
Nov-08	63	98	1	162	2	3	0	5	99	177	1	277	3	10	0	13	106	102	4	212	6	9	1	16
Nov-09	0	0	0	0	0	0	0	0	102	186	5	293	6	9	2	17	0	0	0	0	0	0	0	0
Nov-19	34	50	0	84	0	3	0	3	137	141	0	278	1	5	0	6	14	15	0	29	0	2	0	2
Nov-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	18	0	35	2	1	0	3
Nov-22	21	30	0	51	0	1	0	1	42	60	0	102	1	2	0	3	6	6	0	12	0	0	0	0
Total	228	367	2	597	7	13	0	20	771	1162	10	1943	25	55	2	82	280	341	12	633	15	19	1	35

(a) See Fig. 1 for location of recovery areas

(b) Abbreviations are M=male, F=female, J=jack, T=total