Adult Chinook Escapement Assessment Conducted on the Nanaimo River During 2007

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ADULT CHINOOK ESCAPEMENT ASSESSMENT CONDUCTED ON THE NANAIMO RIVER DURING 2007

by

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ABSTRACT

Damborg J.G., Damborg, M.J., and Carter E.W. 2008. Adult chinook escapement assessment conducted on the Nanaimo River during 2007. Can. Manuscr. Rep. Fish. Aquat. Sci. 2837: vii + 48p.

In 2007, Fisheries and Oceans Canada in co-operation with Snuneymuxw First Nation and Nanaimo River Hatchery continued an escapement study of chinook salmon (*Oncorhynchus tshawytscha*) in the Nanaimo River. Areas of concentration for this study included: i) calculating Petersen population estimates through carcass mark-recapture surveys for fall run chinook; ii) generating an area-under-the-curve population estimate by conducting swim surveys in the lower Nanaimo River for fall run chinook; iii) enumerating summer run chinook by aerial surveys; and iv) collecting biological and coded-wire tag (CWT) data. The estimated total return of fall run adult chinook to the Nanaimo River was 2,322 of which 2,222 spawned naturally. No Petersen mark-recapture estimate was performed in the upper river due to access limitations. Hatchery broodstock collection and overflights estimated the naturally spawning population of the First Lake summer run chinook to be 220 fish and the total return to be 346 fish. Total return of all adult chinook to the Nanaimo River system in 2007 was 2776 fish.

RÉSUMÉ

Damborg J.G., Damborg, M.J., and Carter E.W. 2008. Adult chinook escapement assessment conducted on the Nanaimo River during 2007. Can. Manuscr. Rep. Fish. Aquat. Sci. 2837: vii + 48p.

En 2007, Pêches et Océans Canada, en coopération avec la Première nation Snuneymuxw et l'écloserie de Nanaimo River, a poursuivi l'étude sur l'échappée du saumon quinnat (*Oncorhynchus tshawytscha*) dans la rivière Nanaimo. L'étude visait quatre buts: i) obtenir une estimation des effectifs de la remonte de quinnats d'automne selon la méthode de Petersen par le biais de relevés de dénombrement des carcasses des individus marqués; ii) obtenir une estimation de la population d'après la surface sous la courbe par le biais de relevés de dénombrement en plongée libre des quinnats d'automne présents dans le bas de la rivière Nanaimo; iii) dénombrer les quinnats d'été par relevés aériens; et iv) recueillir des données biologiques et des données de micromarques magnétisées codées. Selon les estimations, la remonte d'automne de quinnats adultes dans la rivière Nanaimo totalisait 2 322 individus, dont 2 222 ont frayé naturellement. Nous n'avons pas fait d'estimation, selon la méthode de Petersen, du nombre de saumons marqués recapturés dans le haut de la rivière en raison de problèmes d'accès. Nous avons utilisé les résultats des relevés aériens, ainsi que l'information recueillie lors du prélèvement de reproducteurs d'écloserie, pour estimer les effectifs de la population de quinnats d'été qui se reproduisent naturellement dans le lac First. Ce nombre se chiffrait à 220 individus, et la remonte totale à 346 individus. En 2007, la remonte totale de quinnats dans le réseau de la rivière Nanaimo se chiffrait à 2 776 individus.

INTRODUCTION

Since 1988, considerable interest has been focused on the status of chinook salmon (*Oncorhynchus tshawytscha*) stocks in the lower Strait of Georgia. The Nanaimo River, Cowichan River and the Squamish River, were chosen to represent the lower Strait of Georgia as exploitation and escapement indicator rivers (PSC 1990). Escapement information is used to evaluate rebuilding strategies and harvest management policies for lower Strait of Georgia chinook (Farlinger et al. 1990). Since then, due to logistical reasons, the Squamish River system was dropped as an indicator. The Nanaimo River system was also dropped as an exploitation rate indicator in 2002 and the enumeration fence was discontinued the following season in 2003. However, the Nanaimo River system remains an important escapement indicator for lower Strait of Georgia chinook with the unique distinction of monitoring one fall and two spring runs.

In 2004 the Cowichan River lost all its brood stock due to heavy snowfall resulting in a power and pump failure. Therefore no fry were available to be coded-wire tagged from Cowichan. As an alternative, Nanaimo River fry were marked and the river became the surrogate indicator river for that brood year. Over the past four years the system has been comprehensively assessed using alternative escapement methods (i.e. Area Under the Curve and Petersen mark-recapture) to estimate the chinook population returning to the watershed. In 2007, DFO, Science Branch, in conjunction with Snuneymuxw First Nation and the Nanaimo River Hatchery continued to operate carcass mark-recapture and swim survey programs to collect chinook escapement and coded-wire tag information.

Nanaimo River chinook exhibit a variety of life history strategies, with at least three genetically distinct runs produced (Carl and Healey 1984). Unique to only a few systems on the East coast of Vancouver Island, there are two distinct spring chinook stocks and one fall run stock returning to the Nanaimo River (Figure 1).

The two spring run stocks enter the river between March and August and hold in First Lake, Second Lake or deep canyon pools until they spawn during late summer/early fall (Blackman 1981, Brahniuk et al. 1993, Nagtegaal and Carter 2000). The upper Nanaimo River spring chinook stock spawns upstream of Second Lake to Sadie Creek, at the outlet of Fourth Lake, in October (Hardie 2002). The majority of fry are stream-type which rear for up to one year before out-migrating to the estuary (Healey 1980, Blackman 1981, Nagtegaal and Carter 2000).

The First Lake summer run spawns within the first 1.6 kilometers downstream of the First Lake outlet to the Wolf Creek junction pool (Healey and Jordan 1982, Hardie 2002). The peak of spawning is typically during the first two weeks of October (Nagtegaal and Carter 2000, Brahniuk et al., 1993). Chinook fry produced from the late spring run are mostly ocean-type and rear for 90 days in freshwater before migrating to sea. Stream-type fry will be more vulnerable to changes in freshwater productivity and habitat conditions than ocean-type fry that out-migrate upon emergence. Once in the estuary, First Lake fry exhibit greater agonistic behaviour than fry produced by the lower Nanaimo stocks due to their longer period of territorial stream residence prior to migration into the estuary (Taylor 1990).

The larger fall chinook stock enters the Nanaimo River during August/September and a large proportion of the run spawns in the lower river downstream of the Borehole/lower canyon area down to the Cedar Road Bridge (Healey and Jordan 1982, Hardie 2002). Some of the fall chinook runs ascend the falls to spawn in the upper river downstream of First Lake. The majority (99%) of fry incubated in the lower river exhibit ocean-type life history strategy and out-migrate to sea upon emergence to rear in the estuary (Healey and Jordan 1982).

Hatchery production of chinook on the Nanaimo River began in 1979 (Cross et al. 1991). In that first year, eggs were incubated at the Pacific Biological Station and later released into the river. The first year of production at the hatchery facility was 1980 (1979 brood) when 100,000 fall run chinook fry were released. Over the years fry production has increased, and in 2007, a total of 421,467 fall run chinook fry and 223,745 First Lake summer run chinook were released into the Nanaimo River watershed. There is no hatchery enhancement for the upper Nanaimo River spring run chinook stock. Coded-wire tagging of chinook began in 1979 and by 2004, 75.6% of fall run chinook fry carried coded-wire tags (CWT). No CWT tagged chinook fry were released in 2006 or 2007. In 2005 Nanaimo River fish were tagged and released instead of the intended Cowichan River fry. The 2004 brood at Cowichan River Hatchery died in a power outage and as a result no fry were raised there. It was decided late in the season to tag the Nanaimo River fish in lieu of.

In addition to chinook, the Nanaimo River also supports stocks of coho salmon (*O. kisutch*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), steelhead trout (*O. mykiss*), cutthroat trout (*O. clarki*), and Dolly Varden (*Salvelinus malma*).

In consultation with various user groups, the B.C. Ministry of Environment, Lands and Parks initiated a Nanaimo River Water Management Plan in June of 1989. The primary goal of the plan was to improve salmon escapement by increasing flows during typically low water levels in the fall while at the same time maintaining adequate flows to satisfy industrial and domestic water use (Ministry of Environment, Lands and Parks 1993).

The objectives of the 2007 escapement study included:

1. Providing fall run, upper river spring run, and First Lake summer run chinook salmon estimates for the Nanaimo River watershed,
2. Estimating the Snuneymuxw First Nation food fishery catch,
3. Recording hatchery broodstock removals of fall and summer run chinook,
4. Implementing a carcass mark-recapture study for both fall run and First Lake summer run chinook,
5. Collecting biological data, recovering CWT's, and
6. Generating an area-under-the-curve (AUC) estimate through swim surveys in the lower Nanaimo River.

This report presents the results of the escapement study completed during 2007.

METHODS

Three methods were employed to estimate chinook spawning escapement in the Nanaimo River. These included carcass mark-recapture techniques, swim surveys, and aerial surveys. The pooled Petersen mark-recapture calculation and the AUC estimate were used to generate a chinook population estimate for lower river stocks only. Aerial surveys were the only method used to estimate upper river spring and summer stocks due to accessibility issues. Biological data including length, sex, scales, presence/absence of an adipose fin, and coded-wire tagged heads were collected from carcasses during the mark-recapture and broodstock collection programs.

MARK-RECAPTURE AND BIOLOGICAL DATA COLLECTION

Escapement estimates were generated from mark-recapture data using the pooled Petersen model (Chapman modification; Ricker 1975) for the fall run adult and jack chinook. The mark-recapture also provided information on length frequencies, age compositions, and sex composition. CWT data were also collected for use in calculating enhanced (hatchery) contribution in the Nanaimo River watershed.

The carcass mark-recapture operation involved two crews of two or three people in inflatable boats searching the river daily for spawned-out chinook carcasses. Each carcass was tagged with a numbered Ketchum[1] aluminum sheep ear tag on the left operculum and released into the river. Fish were also hole-punched in the left operculum in case the aluminum tag was lost. For all recaptures, the tag number and location were recorded. Once recaptured, the carcass was removed from the river to avoid multiple recaptures.

Biological information such as post orbital-hypural (POH) length, sex, capture location, and the presence or absence of an adipose fin were recorded. If the adipose fin was missing the head was catalogued and taken for CWT analysis at the laboratory. Five scale samples were taken from the preferred area to be analyzed for age composition (Shaw 1994). Otoliths were also collected from chinook for examination for thermal marking to assess the possibility of strays from Robertson Creek Hatchery (RCH). Chinook fry released from RCH have been exposed to varying temperatures and as a result, have a specific pattern on their otoliths (Hoyseth and Hargreaves 1995).

Recovery effort was concentrated on two sections of the Nanaimo River watershed. The lower portion focused on sampling fall run chinook, which generally spawn between the Island Highway Bridge and the Cedar Bridge. Carcass recovery for the upper portion of the Nanaimo River watershed targeted First Lake summer run chinook, which spawn in a two-kilometer stretch of river, between the outlet of First Lake and the Wolf Creek outlet. Fish in this upper section were sampled but no mark recapture was completed. The access to the upper river was limited and not until late in the season, once access was made available, was any sampling done in this area. Once access was gained it was deemed too late to begin an effective mark recapture study. Therefore, the upper river summer run estimate is based solely on aerial survey data.

[1] Ketchum Manufacturing Ltd., Ottawa, Canada

Biological information similar to that recorded for the carcass mark-recapture was provided by Nanaimo River Hatchery staff from chinook collected for purposes of broodstock. This included both fall run chinook and First Lake summer run chinook.

Mark-recapture estimates were calculated using a pooled Petersen estimator. Since the true population size was unknown, a direct measure of the accuracy of the estimates was not possible. However, an assessment of the underlying assumptions of equal probability of capture, simple random recovery sampling, and complete mixing can usually be made by testing recovery and application samples for temporal, sex, and size related biases (Schubert 2000). To carry out most of the bias assessments, different gear types must be utilized for capturing the tag application and the recovery samples. In the current study, the spawning ground carcass mark-recapture was used to attain both samples thus limiting the ability to assess sample bias.

Finding sampling bias usually results in the use of a stratified estimator; however, Schubert (2000) compared the performance of several mark-recapture population estimators for a sockeye salmon population of known abundance and concluded that the pooled Petersen estimator was less biased and preferred over stratified estimators. In that study, the Schaeffer estimator would not improve accuracy and it was recommended that the method be abandoned for use in population estimation. Also, it was determined that while the maximum likelihood Darroch estimator could potentially improve accuracy, there was no obvious way of selecting between accurate and highly biased estimates. Parken and Atagi (2000) found that pooled and stratified estimators of Nass River summer steelhead produced similar escapement estimates; however the pooled estimator was more precise, and had less statistical bias than the stratified estimator. These findings indicate the robust nature of the pooled Petersen estimator and suggest that its use to determine population abundance from mark-recapture data is generally appropriate under a wide range of circumstances.

SWIM SURVEYS

Nanaimo River Hatchery staff conducted and coordinated swim surveys to provide an independent estimate of spawning chinook to assess spawning distribution throughout select portions of the lower Nanaimo River. Swim surveys were normally carried out using three swimmers who stay abreast of each other while moving downstream. Swimmers combined individual counts, which were recorded by pre-defined localities in the river (Figure 2).

Nine swim surveys conducted in lower portions of the Nanaimo River watershed between 22 August and 29 October were used to calculate an AUC estimate for fall run chinook (English et al. 1992; Irvine et al. 1993). In this portion of the river, swim counts were combined into four segments.

Two other factors required in calculating an AUC estimate are survey life and observer efficiency (OE). Generally through a tagging process, a survey life statistic is generated. In the fall of 2007 the tagging was carried out, but soon after a major rain event caused highly turbid water in the system for a number of days. Swims were postponed, and by the time they commenced, there were few tagged chinook remaining in the target reaches; therefore, no survey life was generated for 2007. For all AUC calculations, the 2006 survey life of 11.53 days was used. Observer efficiency accounts for fish missed by observers. Observer efficiency varied over the swims, generally high early in the season but decreasing during high water events later in the season. OE's for 2007 ranged from 40% - 95%. The 9 October swim was omitted in AUC calculations due to the poor reliability if the count given the low visibility during the swim.

No swims were conducted in the upper Nanaimo River in 2007.

AERIAL SURVEYS

Three aerial surveys were conducted throughout the Nanaimo River watershed, which were focused on enumerating chinook and chum salmon. The helicopter, an Aerospatiale A-star 350B, was flown at low altitude, approximately 300 feet (~91.4 m), to aid in visibility and identification of salmon species. Counts were made by river pool or river section and combined to obtain a final estimate. Two observers were employed for the aerial survey. Flights took place on 17, 24, and 30 October. The first two flights covered the watershed from the estuary to Second Lake. The final flight that covered from the estuary to First Lake was mainly targeting fall chum.

FIRST NATIONS FOOD FISHERY

In years previous to 2006, catch estimates were received from Snuneymuxw First Nation (SFN) fishery guardians but biological sampling of chinook and coho caught in the river fishery was not undertaken. In 2007, two SFN members familiar with the fishery were hired to go to the river on a regular (near daily) basis and collect biological data from the fishers' catch. Through these data we hope to compare size, age, and mark rates with chinook sampled during the carcass mark-recapture program as well as in the hatchery broodstock.

WATER MANAGEMENT PLAN

Low flows and water levels likely result in delayed fish movement and higher water temperatures, which may potentially increase levels of disease and parasites. This is particularly true for the parasite Ich (*ichthyophthirius*), which matures more rapidly with higher temperature (Ministry of Environment, Lands and Parks 1993). During particularly low water levels, the river flow can be increased with a controlled water release.

Two man-made reservoirs in the Nanaimo River system have been utilized to increase flows during periods of low flow between late summer and early fall. Prior to 1989, water releases were conducted based on an informal arrangement between local Fisheries Officers and Harmac Pacific. Fisheries Officers would request a water release when, in their opinion, fish holding in the lower river became threatened due to low water. These requests would be granted by Harmac dependent upon the availability of water in reserve.

With the increase in population in the Nanaimo area and in an effort to satisfy domestic, industrial, agricultural, fishery, wildlife, and recreational needs, a Nanaimo River Water Management Plan (NRWMP) was initiated by the B.C. Ministry of Environment (BCMOE) in June of 1989. A team comprised of members from the BCMOE, Greater Nanaimo Water District, MacMillan Bloedel Limited, Snuneymuxw First Nation, and Fisheries and Oceans Canada (DFO) negotiated a water flow management plan (Ministry of Environment, Lands and Parks 1993). The primary water management issue has been to enhance flows to meet fisheries requirements while maintaining flows to satisfy industrial and municipal needs. This is particularly important during periods of lowest flow (September and October) and in the ten-kilometer section of river below the Harmac Pulp Operations water intake area. Increases in the fall water releases from the reservoirs since 1989 have encouraged spawning migration.

The Nanaimo River Water Management Plan also incorporates the ramping (a gradual increase and/or decrease) of water levels to minimize effects of sudden changes in river dynamics. Possible effects include the stranding of fish, alteration of river hydrology, and erosion of riverbanks. The recommended minimum duration of a water release is 48 hours, with the optimum release time being three to four days. The recommended minimum discharge for a water release is 14.87 m^3/s (525 ft^3/s), to be released from Fourth Lake (Hop Wo et al. 2005).

RESULTS

CARCASS MARK-RECAPTURE

In 2007, the carcass mark-recapture program was completed only on the lower Nanaimo River. Access to Wolf Creek in the upper Nanaimo River was gained too late to begin a mark-recapture study, however, carcass recovery and bio-sampling were completed. Daily Nanaimo River discharge for the duration of the carcass mark-recapture is presented in Table 1 and Figure 3.

Lower Nanaimo River

The lower Nanaimo River carcass mark-recapture commenced on 18 October, occurred over 17 days, and was completed 9 November 2007. Male chinook observed on the carcass mark-recapture were designated adult or jack based on size. The ability to divide males based on age was utilized once the scales were read.

Age information provided from scale data was preferred, as 12 adults were found to be incorrectly identified. All misidentified fish were males with POH lengths of 444 mm to 594 mm that had European ages of 0.1. These were the only discrepancies between scale data and length data in male chinook. Carcass mark-recapture data were slightly adjusted to account for the discrepancies between age classes as denoted from the field data versus scale data. There was no differentiation made for female chinook regardless of scale age data.

During the sampling period, 107 male, 101 female, 109 jack and two unknown adult chinook were tagged and released in the lower Nanaimo River (Table 2). Tagged carcasses recaptured included 37 (34.6%) males, 28 (27.7%) females, and 28 (25.7%) jacks. Using the Petersen estimator, the total adult lower Nanaimo River fall run chinook population estimate was 957 adults (95% CI: 756 – 1158) and 523 jack (95% CI: 357 – 670) (Table 3).

Potential Biases

The assessment of sampling selectivity had several potential biases in the carcass mark-recapture study.

1. Temporal Bias:

Temporal recovery bias is assessed by stratifying application data into four discrete periods and comparing recovered and unrecovered tags to total tags applied. The first period included one extra day of application to account for fewer tags in the system at the beginning of the study. A Chi-square test was performed on males, females, jacks and combined adults,. A highly significant temporal bias was found with all the adults. Males (Chi-Square = 22.60; $p = 0.05$), females (Chi-Square = 21.98; $p = 0.05$), and pooled sexes (Chi-Square = 39.82; $p = 0.05$). Jacks (Chi-Square = 7.32; $p = 0.05$) showed no significant recovery bias over time.

Temporal application bias is assessed by stratifying recovery data into four discrete periods and comparing tagged and untagged recoveries to total recoveries. The same time periods were used in these calculations. A Chi-square test was performed on males, females, jacks and combined adults,. A highly significant temporal bias was found with all the adults; Males (Chi-Square = 10.36; $p = 0.05$), females (Chi-Square = 10.76; $p = 0.05$), and pooled sexes (Chi-Square = 18.68; $p = 0.05$). Jacks (Chi-Square = 4.24; $p = 0.05$) showed no significant application bias over time.

2. Fish Sex Bias: Sex related bias was examined by comparing the sex ratios of the application samples and recovery samples for adult males, females and jacks. No sex related bias was evident when comparing male, female or jack populations between the application and recovery samples (Chi-Square = 0.58; $p < 1.0$).

3. Size Bias: Size related bias was examined by comparing the mean POH lengths of marked chinook and recovered chinook by sex. No significant size bias was evident in the recovery samples of adult male, female, or jack chinook (Students t-test: $t = .97$; $p < 1.0$, $t = 0.60$; $p < 1.0$, and $t = 0.03$; $p < 1.0$ for males, females, and jacks, respectively).

Upper Nanaimo River

Due to road deactivation in the upper watershed there were no mark recapture data collected for the upper Nanaimo River summer run. Later in the season once access was established, bio sampling was completed over three days between 2 and 9 November. At that point it was too late to commence a mark recapture study as many carcasses were already present and others had likely been washed out of the area.

SWIM SURVEYS

In 2007, a total of nine swim surveys were conducted in the lower portion of the Nanaimo River to determine chinook abundance and distribution (Table 4). Due to restricted access, no swims were conducted in the upper Nanaimo River. Swims in the lower river began on 22 August and ended on 29 October. Most of these swims started at the Island Highway Bridge pool and ended at Raines Rock pool within tidal influence and targeted fall run chinook. The final lower river swim on 29 October, targeted fall run chinook between the Island Highway Bridge pool and the Fire Hall pool, due to high numbers of chum and few chinook downstream of the Fire Hall pool. The first two swims on 22 and 27 August were focused on examining upper Nanaimo River spring and summer run chinook.

Swim surveys conducted in lower portions of the Nanaimo River Watershed between 5 September and 29 October were used to calculate an AUC estimate for fall run chinook. These swims were differentiated into four segments which contained multiple adjacent pools and riffle sections, specifically; Segment 1, Bridge Pool to Alder Run; Segment 2, Haslam Creek Junction to House Pool; Segment 3, Maffeo Side Channel to Fire Hall; and Section 4, Barn Hole to Raines Pool (Figure 2). Daily Nanaimo River discharge during the course of the swim surveys is presented in Figure 3.

AREA UNDER THE CURVE

In 2006, the process was completed to establish the survey life of Nanaimo River chinook. Two reconnaissance swims were conducted prior to the tagging day and on 28 September, 145 chinook comprised of 45 adult males, 50 females and 50 jacks were tagged with fluorescent spaghetti tags and released in the San Salvadore area. A follow up swim was conducted on 29 September to count the number of tagged fish in the system. Subsequent swims were conducted weekly to estimate the overall number of chinook in the lower river as well as count the remaining tagged chinook. Through this process a survey life statistic of 11.53 days was generated.

In 2007 a survey life estimate was attempted and tagging was completed, but due to a storm event delaying swims, an accurate survey life could not be derived. A start date of 22 August was chosen as a time just before fall run chinook entered the survey area (approximately two weeks before the first swim). The last of the fall run chinook were estimated to have entered the river two weeks after the last swim, yielding an end date of 12 November.

Another factor used in calculating an AUC estimate is observer efficiency, which accounts for fish missed by observers. Factors affecting observer efficiency are water turbidity, lighting conditions, as well as areas where fish can hide such as deep pools or log jams. Observer efficiency was variable during swims in 2007, ranging from 40% - 95%. Species identification was taken into account when calculating the AUC estimate, as was the amount of habitat surveyed compared to the amount of habitat available

The calculated AUC estimate for fall run adult chinook in the lower Nanaimo River is 2322 fish. An AUC estimate was also generated for fall run jack chinook within the lower Nanaimo River using the same survey life (11.53 days) and observer efficiencies as adult chinook. This methodology yielded an estimate of 1973 jack chinook. Please note, both of these AUC estimates are for total returns and have not been adjusted for broodstock removals. Swim survey counts with expanded estimates are presented in Table 4 and Figure 5.

No AUC estimate was calculated for the summer run chinook as there were no swims targeted at this group.

AERIAL SURVEY

Three aerial surveys were conducted to enumerate spawning chinook, these overflights were conducted on 17, 24, and 30 October. The primary purpose of these flights was to examine chinook spawning distribution and enumerate chum salmon in the Nanaimo River. All flights occurred under clear conditions during low to moderate river flows. Low flows may have encouraged fish to hold in deep river pools before higher flows could aid chinook migration to spawning areas. The first two flights yielded an estimate of 210 and 220 summer run chinook within the Nanaimo River. The third flight on 30 October was mainly targeting the chum run (Table 5).

FIRST NATION FOOD FISHERY

An in-river chinook rod and gillnet fishery takes place in September and October to provide food, social, and ceremonial fish for the SFN. This fishery is held in a one-kilometre area downstream of the Cedar Bridge and monitored by the SFN Fisheries Guardians. In 2007, the observed chinook catch was 225 (approximately 143 adults and 82 Jacks).

In years prior to 2006, catch estimates were received from the SFN guardians, however the guardians were unable to attain biological samples from chinook and coho caught in the in-river fishery. In 2007, two SFN members familiar with the fishery were hired to collect biological data from the fishers’ catch. Sampling took place over 19 days from 23 September to 24 October.

BROODSTOCK REMOVALS

From 14 October to 9 November, the Nanaimo River Hatchery’s field records show 52 male, 48 female, and 44 jack fall run chinook were collected for broodstock purposes from lower portions of the Nanaimo River (Table 6). From 04 October through to 31 October, 61 male, 65 female and 12 jack First Lake summer run broodstock chinook were collected from First Lake. No upper Nanaimo River spring run chinook were removed for hatchery broodstock.

BIOLOGICAL DATA

During the lower Nanaimo River spawning ground carcass mark-recapture, 107 male, 101 female, two unknown adults and 109 jack fall run chinook carcasses were sampled and measured for post orbital-hypural (POH) length (Table 2). The lengths of adult male chinook carcasses ranged from 47 cm to 77 cm and averaged 60.4 cm. Adult female carcasses ranged from 37 cm to 78 cm and averaged 64.3 cm. Jack chinook carcasses ranged in lengths from 28 cm to 47 cm and averaged 42.9 cm (Table 7A).

A total of 18 (17%) male, 34 (34%) female, and three (2.8%) jack chinook were missing adipose fins. Age analysis of male chinook revealed that 59.5% were two years old, 21.6% were three years old, and 18.9% were four years old (Table 8A). Analysis of female chinook scales indicated that 3.1% were two years old, 56.3% were three years old, and 40.6% were four years old. No sampled fish had scales exhibiting over-wintering in freshwater.

During the upper Nanaimo River spawning ground carcass biological sampling (Table 9), 16 male, 46 female, and five jack summer run chinook carcasses were sampled and measured for POH length. The lengths of adult male chinook ranged from 52.9 cm to 72.8 cm and averaged 64.2 cm. Females ranged from 51.3 cm to 81.0 cm and averaged 62.4 cm, and jacks ranged from 33.3 cm to 44.9 cm and averaged 40.5 cm (Table 7B). No upper river chinook were found missing an adipose fin.

Age analysis of male chinook revealed that 12.5% were two years old, 75.0% were three years old, and 12.5% were four years (Table 8B). Analysis of female chinook scales yielded that 3.4% were two years old, 90.5% were three years old, and 10.3% were four years old. All upper river chinook were found to be ocean-type chinook fry, as all scales exhibited no over-wintering in freshwater. Of fish sampled during the carcass mark-recapture operations, there was no significant difference between the mean lengths of lower and upper river male chinook (Students t-test: $t = 1.11$; $p<0.5$), or between the mean lengths of lower and upper river female chinook ($t = 1.56$; $p<0.2$) or between the mean lengths of lower and upper river jack chinook (Student's t-test: $t = 1.31$; $p < 0.2$).

A total of 31 adult male, 43 female, and 41 jack fall run chinook were sampled from hatchery broodstock, measured for POH length, scale sampled and examined for adipose-clipped fins. Adult male chinook ranged from 47 cm to 78 cm and averaged 55.8 cm. Female chinook lengths ranged from 51 cm to 79 cm and averaged 63.0 cm, jack chinook ranged from 37 cm to 47 cm and averaged 43.3 cm (Table 10).

Eight (26%) adult males, 32 (74%) females, and one (2.4 %) jack were found to be missing adipose fins (Table 10). Fish identified as male chinook were 71.9% two years old, 25.0% three years old and 3.1% four years old. Female chinook were 90.0% three years old and 10.0% four year olds (Table 11A).

Summer run chinook taken for broodstock from the upper Nanaimo River were aged as follows: males – 46.2% two years old, 46.2% three years old, and 7.7% four years old; females –

13.3% two years old, 73.3% three years old, and 13.3% four years old, (Table 11B). All summer run chinook were found to be ocean-type chinook as no scales exhibited over-wintering in freshwater.

When comparing mean lengths of male fall run chinook recovered from the lower Nanaimo River spawning grounds to male hatchery broodstock samples, it was found that the broodstock fish were significantly smaller than the fish from the Petersen mark-recapture study (Student's t-test: $t = 2.27$; $p < 0.1$). T-test comparisons between mean length of female chinook sampled at the hatchery and female chinook recovered in the lower carcass recapture programs revealed no significant difference in mean length (Student's t-test: $t = 1.05$; $p < 0.1$).

Comparisons between mean lengths of female summer run chinook recovered on the spawning grounds and chinook sampled from hatchery broodstock yielded no significant difference (Student's t-test: $t = .42$; $p < 1$). Summer run male fish sampled were significantly larger than the fish sampled from hatchery brood stock (Student's t-test: $t = 3.30$; $p < 0.01$).

No significant difference was found between the mean lengths of summer jack chinook sampled at the hatchery and those from the upper river carcass mark-recapture program (Student's t-test: $t = 0.72$; $p < 1.0$). Similarly, there was no significant statistical difference between the mean lengths of fall run jacks sampled at the hatchery and those from the lower Nanaimo River carcass recapture program (Student's t-test: $t = 1.95$; $p < 0.1$).

A highly significant difference was found between the mean lengths of female and male fall run broodstock sampled at the Nanaimo River hatchery (Student's t-test: $t = 4.90$; $p < 0.0001$). Females were significantly larger.

Fifty-five chinook carcasses recovered on the spawning grounds were found to have been missing adipose fins, and 51 of these fish contained CWT's (Table 12). All adipose-clipped fish were recovered in the lower Nanaimo River. Forty-nine chinook identified as having a CWT were reared at the Nanaimo River Hatchery all from the 2004 brood year. The two remaining tags were released from the 2003 and 2005 Chemainus River brood. The final four adipose-clipped chinook had unusable CWT's and are of unknown origin.

The number of chinook sampled in the SFN FSC fishery included 33 adult males, 65 females and 62 jacks (Table 13). Ten chinook were observed caught but not bio-sampled. A total of 47 coho were also sampled. Jack chinook lengths ranged from 399 mm to 532 mm (mean length = 470 mm), adult males from 481 mm to 811 mm (mean length = 601 mm), and females from 402 mm to 826 mm (mean length = 610 mm). In addition, the sampler observed 10 coho and 28 chum salmon caught but not sampled. A sub sample of scales revealed that 19 (56%) had a European age of 0.1 (including 5 females), 13 were aged 0.2 (38%), and two were aged 0.3 (6%) (Table 11C). All chinook sampled were found to be ocean-type as no scales exhibited over-wintering in fresh water.

Of the 170 chinook sampled, 28 were missing adipose fins indicating possible CWT's. Their heads were sent to the lab for CWT detection and decoding. Seventeen CWT's were recovered and 16 of these were reared in the Nanaimo River from the 2004 brood year and released in 2005. The 17th was a chinook from the Chemainus River 2003 brood year and released in 2004 (Table 14).

The Nanaimo River Hatchery found 41 chinook collected for broodstock purposes to be missing adipose fins, denoting a possible CWT. 100% of the 41 fall run chinook heads sent in for analysis were found to contain CWT's. Of these, all except one were found to have been Nanaimo River origin from 2004 brood. The remaining fish was from 2005 Chemainus brood (Table 15). The lack of 2003 brood year recoveries from the Nanaimo River was due to no CWT fry released in that year. For a list of Nanaimo River Hatchery fry releases, brood years 1997 – 2006, see Table 16. For fry releases to the Chemainus River and Cowichan River Watershed, brood years 2002 – 2006, see Table 17.

A comparison between female chinook mark rates obtained from lower Nanaimo River carcass mark-recapture and fall run broodstock collection yielded a significantly higher mark rate for broodstock fish (Chi-Square = 9.321; $p<0.01$). However, when comparing males obtained from fall run chinook collected in the carcass mark-recapture and broodstock, there was no statistically significant difference (Chi-Square = 0.227; $p<1.0$). Also, there was no significant difference when comparing the mark rates of jacks between hatchery brood stock collection and carcass mark recapture (Chi-Square = 0.000; $p<1.0$). A comparison between male and female summer run chinook mark rates obtained from the carcass mark-recapture and broodstock was not possible as no upper river chinook collected were missing an adipose fin.

Otoliths were collected from 192 carcasses from the lower river (65 male, 60 female, 63 jack) and 67 from the upper river (16 male, 46 female, 5 jack) river chinook. Nanaimo River Hatchery staff collected 60 otoliths from fall run and ten from summer run broodstock chinook in 2007. At this point the otoliths have not yet been analysed for thermal markings.

WATER MANAGEMENT PLAN

In 2007, the scheduled water releases did not occur due to a surplus of water from heavy rains during the usual release period (early October). The Jump Lake reservoir was left open at 300 cfs for the entire month of October with the exception of the following days: 1, 2, 5, 19, 30 and 31 October. Flows during October were well above target release rates for migrating salmon (~15m^3/s) with a minimum flow of over 20 m^3/s for the entire month. Daily Nanaimo River discharge is presented in Table 1 and Figure 3. A summary of mean monthly Nanaimo River discharge and historical monthly mean is presented in Figure 4.

POPULATION ESTIMATE

The total return of chinook to the Nanaimo River Watershed was 4,954 fish, including 2,061 jacks. The number of naturally spawning fall run adult chinook in the Nanaimo River during 2007 was determined to be the AUC swim survey estimate (2,322 fish) minus the net fall run broodstock removals (100 fish). Following this methodology, the total number of adult fall run chinook spawning in the Nanaimo River was estimated to be 2,222 fish (Table 18A). The total return of adult fall run chinook to the Nanaimo River was determined to be the sum of the AUC swim survey estimate (2,322 fish), and the First Nation fishery catch (225 fish), yielding 2,547 fish. The Petersen mark-recapture calculation was also employed to estimate the fall run population. Through this methodology, the estimate was 957 adults and 523 jacks (Table 3).

An AUC estimate for fall run jack chinook (1,973 fish), minus broodstock removals (44 fish), yielded 1,931 natural spawners. The total return of fall run jack chinook to the Nanaimo River was determined to be the AUC estimate of 1,973 fish.

No Petersen mark-recapture was performed in 2007 on summer run chinook. Using overflights as the only escapement estimate, the number of returning summer run fish was estimated to be 220 live plus dead (Table 5) plus the broodstock capture of 126 adult. This yields a total summer run return of 346 adults. No jack estimate can be determined from the data available.

The total return for all jack chinook to the Nanaimo River was estimated to be the total fall run jack chinook (1,973), plus total First Lake summer run jack chinook (12 fish), yielding 1,985 fish (Table 18B).

No escapement estimate was produced on the upper Nanaimo River spring chinook run in 2007.

The overall enhanced (hatchery) contribution is calculated by expanding the mark rate observed in the Carcass Mark Recapture program (deadpitch) with the ratio of marked to unmarked hatchery releases. Hatchery broodstock are not used in the calculation because the capture method is much less random than the dead pitch. Total fall run chinook (adults and jacks) enhanced contribution was determined to be 32.3% in 2007. Annual natural and enhanced (hatchery) contributions to fall run adult chinook escapements from 1982 to 2006 are presented in Figure 6.

DISCUSSION

CARCASS MARK-RECAPTURE

Variable water conditions existed through most of the mark-recapture program, which commenced on 18 October and ended on 9 November. Water levels were relatively high during most of the mark-recapture program, and remained near $100m^3/s$ from 20 October to 23 October. These high flows may have flushed fish out of the system or may have caused many of the carcasses to be washed up on the bank as the water receded. The carcasses may then not properly mix and be easily recaptured later on in the study. Biases in the data collection may explain the large difference in population estimates between the AUC and Petersen methods. Without proper mixing and closed containment of the population, it is easy for live or dead fish to enter and leave the sampling area biasing results. Also, high flow event may cause a significant proportion of both tagged and untagged carcasses to be removed from the sample area, resulting in a low Petersen estimate.

A large rise in water discharge commencing on 8 November and peaking on 12 November saw an increase from 13 m^3/s to nearly 288 m^3/s within that four-day period. Several other peaks earlier in the spawning season included a peak of 50 m^3/s on 3 October, and two larger peaks of just under 100 m^3/s which occurred on 8 October and 20-23 October (Table 1; Figure 3). The large flood event on 12 November ended the survey as water levels were too high to perform any in-river activities. It appears that this year's data are consistent with last year's, that is, a much higher estimate was determined from the AUC than the mark-recapture.

Lower Nanaimo River

When comparing the mark rates between the hatchery samples to the lower river carcass mark-recapture program, a Chi-Square analysis was performed. The result indicates a significant difference between the hatchery mark rate to that of the lower river program. Hatchery samples were marked at a significantly higher rate than those recovered on the river (Chi-square = 15.31; $p<0.0001$).

Significant temporal bias was found for both application and recovery samples for males females and pooled adults. This bias however is not entirely unexpected as through the study period more and more fish are available for recapture as more fish are marked over time. The expected bias leans towards a higher rate of recovery later in the study, which was the case in 2007 (Table 9). Jacks, however; showed no significant temporal bias for either application or recovery. This could be a result of the smaller size of the jacks but size bias testing showed no significant difference in recovery or application rates related to fish size. Also, with relatively small sample sizes (as few as 3 or 4 recoveries in an application period) used in these calculations, only a few fish may make a significant difference.

Water discharge can play an important role in the success of the mark-recapture program and with very large fluctuations in water discharge over the sample period, mixing may be variable and access can be difficult. Also, there can be problems with predators (bears) that may remove the tagged carcasses from the sample area, especially during the beginning of the study. After some time the bears will become satiated and remove fewer carcasses (D. Nagtegaal, DFO Stock Assessment Biologist, 5353 Club Road, Duncan, B.C., V9L 3X3. pers. comm.) biasing the results.

There are also other problems associated with the use of a Petersen mark-recapture study in a river application like the one used. One of the fundamental necessities for a mark-recapture program like this one is the population must be contained. This is not the case as live fish can enter into the sampling area, leave the sampling area, as well as carcasses can leave and enter the area especially during high flows.

No sex related bias was evident in the application or recovery samples when male and female were compared or when all chinook were compared, suggesting gender was not a contributing factor in the recovery of tagged carcasses.

Size bias testing did not provide an assessment of the size selectivity of the sampling method since both application and recovery samples were attained using the same method. Rather, the size bias assessment provided an evaluation of the recoverability, based on the sizes of tagged carcasses that were redistributed back into the river after tagging. Testing revealed that there were no size biases for male, female, or jack chinook between application and recovery samples.

Upper Nanaimo River

The 2007 total estimate of 345 adult summer run chinook was very similar to the 1995-2005 average of 357 fish. The jack chinook brood catch of 12 fish was the only information obtained for summer run jack. No actual estimate was determined, as jacks cannot be estimated via aerial surveys. As well, no historical comparison can be made as no jack chinook carcasses were recovered previous to 1995 (Hop Wo et al. 2006). Through aerial surveys, only a rough estimate is provided. Ideally, some swim surveys would have taken place and an AUC calculated for the summer stock.

SWIM SURVEYS

Swim surveys conducted in the lower portion of the Nanaimo River provided the primary information for generating a population estimate and a spawning distribution of fall run chinook. The last date, 12 November, used in AUC calculations, assumes that no more chinook were available to be counted on or after this date. Any chinook entering the system after this date would not be included in the AUC estimate. A tagging study in 2006 conducted to obtain the survey life statistic for lower Nanaimo River chinook, generated an estimate of 11.53 days.

The fall run jack chinook estimate generated by AUC calculations utilized the same observer efficiency applied to adult chinook, as no specific observer efficiency was available for jacks. As jack chinook are physically smaller than most adults, jacks may be harder to see in the river and would therefore have lower observer efficiency, resulting in increased expansions to the estimates. Similarly, the survey life statistic of 11.53 days was intended for adult chinook, and therefore assumes that adults and jacks are both available to be counted for the same amount of time.

No swim surveys in the upper Nanaimo River occurred in 2007. Final estimates were obtained exclusively from aerial surveys.

AERIAL SURVEY

The aerial surveys provide an independent estimate of summer run chinook as well as spawning distribution, especially in the upper reaches of the Nanaimo River watershed. During swims for fall run chinook in the lower Nanaimo River, some misidentification is possible as chum salmon are the most abundant species in the latter part of in-migration in that area. However, in the upper portions of the Nanaimo River the misidentification of chinook is less likely, as summer chinook are the only species to normally utilize this area of river at this time of year. Aerial estimates may include some jack chinook.

FIRST NATIONS FOOD FISHERY

Catch estimation procedures developed by the Snuneymuxw First Nation have not been assessed by stock assessment staff. As a result, no comments can be made regarding the methodologies used. The 2007 minimum catch estimate for the SFN fishery has been determined as 225 adult chinook. For the purpose of total river returns, this observed catch of 225 adult chinook will added to the escapement. This estimate cannot be compared to previous years' estimates because it has not yet been expanded for the entire fishery. While DFO did employ two SFN members to monitor the in-river fishery, their aim was to collect biological samples from the catch. In the future the DFO intend to develop a sampling strategy that will better collect effort along with catch information, allowing a more defensible estimate.

BIOLOGICAL DATA

Both mark-recapture samples and broodstock samples collected from fall run chinook were expected to have negligible variation in lengths, as they were retrieved from the same population. Male fall and summer run broodstock were found to be significantly smaller than the fish sampled on the spawning grounds. There was no statistical difference between fall or summer run females when comparing broodstock and fish sampled on the spawning grounds. There was, however, a highly significant difference of mean lengths between the sexes in the hatchery samples. Females (mean length 630 mm) were significantly larger than adult males (mean length 558 mm) (Student-t: $t=-4.90$, $p<0.0001$).

There were no significant differences between the jack populations for both the summer and fall groups when comparing hatchery broodstock and fish sampled on the spawning grounds.

There was no statistically significant difference in adipose fin-clip mark rates between fall run male chinook obtained from mark-recapture and from broodstock collection. Conversely, there was very significant statistical difference between adipose fin-clip rates of female fall run chinook carcasses collected on the spawning grounds and those collected for broodstock. The mark rate for hatchery brood caught fish was 74% compared to 34% for fish sampled during the Petersen mark-recapture study. Using Chi-Square analysis to test for a statistical difference between summer run chinook collected during mark-recapture and broodstock collection was not possible, as there were no adipose-clipped recoveries.

Of the 158 CWT's decoded from the carcass mark-recapture, SFN food fishery, and the hatchery broodstock collection, all but four were released from Nanaimo River hatchery. Also, all Nanaimo released fish with CWT's were from the 2004 brood year. The remaining four were released into the Chemainus River from 2003 and 2005 brood years. This indicates that very few fish strayed from their output streams. This number is considerably lower than the previous two years when in 2006, 24.8%, and in 2005, 29.5% of the fish recovered in the Nanaimo River were strays from the Chemainus River.

This large reduction in straying fish is difficult to explain as release dates have been consistent over the last five years. There were no CWT released fish in the Chemainus River from the 2004 brood year, so only fish that were tagged and had a 0.3 or 0.1 European age from Chemainus would indicate strays. It is very likely that fish are straying at similar rates as previous years, but this cannot be confirmed without the application of CWT's. The CWT program for the Nanaimo River also ended in 2004, which explains why there were no fish with CWT's from 2005 or 2006.

WATER MANAGEMENT PLAN

In previous years (1995 – 2003), water release successes were evaluated by monitoring movement of chinook past the enumeration fence, however, since there is no longer a fence program, this was not possible in 2007. Previous successes with water releases suggest that they are beneficial in aiding and encouraging chinook migration (Hop Wo et al. 2005). Due to heavy rains, it was not necessary to implement the planned water releases this year, as natural flows for October were well above the target flows outlined in the WMP of 14.87 m^3/s.

POPULATION ESTIMATE

The 2007 Nanaimo River fall run chinook population estimate was based on the AUC swim survey calculation that produced estimates of 2,322 adults and 1,973 jacks. One of the goals of this study was to have two independent and analytical methods of estimating the population of fall run chinook. The carcass mark-recapture program provided the data to calculate a Petersen estimate. Therefore, the fall run chinook population was estimated by both the AUC and the Petersen calculations.

Through the Petersen methodology the estimate was 957 adults and 523 jacks. As mentioned, changing river conditions can affect the mark and recapture rates; also redistribution of carcasses in the system may have been insufficient. As a result, the number recaptured may be biased high, which would lead to a low estimate. This likely explains the large difference between the AUC and Petersen estimates. For an example, the peak jack count on 26 September was 537, which is above the jack chinook Petersen estimate for the entire season. This confirms that the Petersen estimate is biased low for the jack population and is likely similar for the adult estimate.

The natural spawning estimate of fall run adult chinook (2,222) is approximately 65% higher than the 1995-2005 average of 1,225 fish. However, given that there have been several methods used to estimate the total return; it is difficult to make true comparisons. Annual fall run adult chinook estimates by type (fence, Petersen mark-recapture, and AUC) are presented in Figure 7.

The First Lake summer run chinook estimate is historically obtained by swim surveys which were not conducted in the 2007 spawning season. Additionally, the Petersen mark-recapture estimate did not take place due to accessibility problems early and mid-way into the season. The naturally spawning estimate for summer run adult chinook of 346 fish is very close to the 1995–2005 average of 357 fish and about one half of last year's estimate of 672. Annual adult chinook escapements are presented in Figure 8.

The fall run natural spawning estimate of 1,973 jacks is over double the 1995–2005 average of 856 fish. The Petersen estimate of 523 is only two thirds of this ten-year average. There was no estimate determined in 2007 for summer run jack chinook and therefore cannot be compared to historical data, which are sparse and in many years no summer run jacks were observed.

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Table 1. Nanaimo River daily discharge[1] (m^3/s), 2007.

	Month											
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	52.5	25	26.5	25.1	43.6	28.7	15.9	6.46	5.42	38	18.7	15.8
2	488	22.6	23.6	22.9	34.1	29.7	13.8	6.3	5.42	42.5	16.7	15.8
3	431	20.6	22.2	20.9	32.7	30	12.7	6.06	5.49	46.7	13.7	275
4	196	19.6	21.8	19.2	30.8	30.4	12	6	6.06	39.6	14.2	789
5	117	19.6	23.6	18	27.5	27.8	10.9	5.78	6.29	30.4	14.4	441
6	143	22.6	31.5	17.4	24.8	24.9	11.2	5.44	6.19	21.3	13.2	198
7	183	31.8	91.5	21.2	24.2	21.4	9.96	5.02	5.93	60.2	12.7	110
8	172	66.4	126	33.7	30.2	17.9	9.54	4.9	5.71	95.4	13.7	74.1
9	167	74.1	148	53.9	34.4	16.2	8.8	4.82	5.65	63.9	27.3	53.4
10	189	82.2	142	54.8	32	18.8	8.29	-	5.71	60.7	78.6	41.1
11	120	83.9	311	41.7	28.6	22.5	8.07	-	6	56.8	89.3	35.3
12	79.2	78.5	510	32.9	26.4	22.7	7.91	-	6.37	47.3	288	-
13	57.2	71.4	226	30.2	25.2	19.4	7.89	-	6.42	36.6	249	-
14	43.8	61.5	115	69.8	24.1	17	7.68	-	6.4	29.5	123	-
15	36.3	70.1	76.1	76	23.2	15.6	7.34	5.42	6.39	25	114	-
16	31.5	88.8	60.6	60.9	25.3	15	6.58	5.4	6.18	23.5	219	-
17	27.5	80.5	60.8	49	25.8	15.7	6.23	5.45	5.44	23.5	152	-
18	23.7	92.6	72.2	40.3	24	15.3	6.04	5.58	5.21	33.1	96.4	-
19	26.7	88.4	94.3	34.7	23.4	14.2	5.89	5.66	5.16	64.6	70	-
20	30	93.8	134	28.8	34.7	13.5	6.3	5.65	5.14	98.9	53.4	-
21	30	79.3	105	25.7	47.9	13.2	8.36	5.61	5.13	87.1	38.2	-
22	45.9	60.9	75.7	23.4	46	12.9	31.3	5.59	5.12	97.1	29.5	-
23	139	46.7	79.7	22.5	40.7	12.7	38.6	5.57	5.11	98.6	23.9	-
24	171	38.7	145	23.3	35.4	12.7	31.3	5.65	5.08	76.9	22.5	-
25	125	36.8	157	27.6	33	12.8	21.6	5.68	5.13	55.8	20.1	-
26	87.6	35.8	104	34.8	32.6	12.3	15.7	5.69	5.82	41.6	18.5	-
27	65.2	33.1	70.5	92.5	31.7	10.9	12.4	5.68	8.66	33.5	17.5	-
28	50.1	29.4	49.7	133	28.1	11	10.3	5.66	8.2	28.6	16.8	-
29	40.1		36.1	91.9	24.3	14.6	8.89	5.56	6.53	26.2	17.6	-
30	34.6		30.9	61.9	23.4	16.5	7.52	5.45	24.2	24.2	16.6	-
31	30		27.5		26		6.81	5.42		20.2		-
Total	3432.9	1554.7	3197.8	1288.0	944.1	546.3	375.8	145.5	195.6	1527.3	1898.5	2048.5
Mean	110.7	55.5	103.2	42.9	30.5	18.2	12.1	5.6	6.5	49.3	63.3	186.2
Max	488.0	93.8	510.0	133.0	47.9	30.4	38.6	6.5	24.2	98.9	288.0	789.0
Min	23.7	19.6	21.8	17.4	23.2	10.9	5.9	4.8	5.1	20.2	12.7	15.8

[1]Data recorded at Water Survey Canada Station 08HB034 which is located upstream of the "Bungy Zone" in Cassidy, B.C.
Discharge data are preliminary and subject to revision.

Table 2. Daily summary of fall run chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2007.

Date	Carcasses Examined				Tags Applied				Recaptured Carcasses			
	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown
18-Oct	4	9	6	0	4	9	6	0	0	0	0	0
19-Oct	6	4	4	0	6	4	4	0	0	1	2	0
22-Oct	1	6	1	0	1	6	1	0	1	1	1	0
23-Oct	8	5	4	0	8	5	4	0	1	1	0	0
24-Oct	9	11	6	0	9	11	6	0	2	0	1	0
25-Oct	4	8	7	0	4	8	7	0	1	0	0	0
26-Oct	7	7	14	0	7	7	14	0	2	3	2	0
29-Oct	10	3	9	0	10	3	9	0	1	1	2	0
30-Oct	15	11	12	0	15	11	12	0	2	3	2	0
31-Oct	6	5	8	0	6	5	8	0	4	2	2	0
1-Nov	5	4	6	0	5	4	6	0	1	1	0	0
2-Nov	6	3	4	1	6	3	4	1	3	2	5	0
5-Nov	9	10	5	0	9	10	5	0	6	1	4	0
6-Nov	7	5	8	1	7	5	8	1	2	5	2	0
7-Nov	6	4	9	0	6	4	9	0	2	4	2	
8-Nov	4	4	5	0	4	4	5	0	4	3	3	
9-Nov	0	2	1	0	0	2	1	0	5	0	0	
Total	107	101	109	2	107	101	109	2	37	28	28	0

Table 3. Petersen fall run chinook escapement estimates by sex, lower Nanaimo River, 2007.

Sex	Population Estimate	95% Confidence Limits	
		Lower	Upper
Adult Male [1]	412	300	523
Female	457	313	601
Total Adult [2]	**957**	**756**	**1158**
Jack	523	357	670
Total Population	**1480**	**1113**	**1828**

[1]Jacks not included.
[2] Population estimate includes 2 unknown sex adults in calculation and is calculated based on 220 marked and 65 recaptured adults

Table 4. Swim survey counts for adult chinook with observer efficiency and system estimates, conducted on the Nanaimo River, 2007.

		Chinook Counts				Estimated Chinook				In-River Chinook Estimate (L+D)		
Swim Date	Observer Efficiency	Live Adults	Dead Adults	Live Jacks	Dead Jacks	Live Adults	Dead Adults	Live Jacks	Dead Jacks	Adults	Jacks	Comments
22-Aug	95%	75	0	0	0	79	0	0	0	79	0	**A**
27-Aug	95%	50	0	91	0	53	0	96	0	53	96	**A**
5-Sep	92%	284	0	419	0	309	0	455	0	309	455	**A**
10-Sep	91%	400	0	506	0	440	0	556	0	440	556	**A**
17-Sep	91%	675	0	368	0	742	0	404	0	742	404	**A**
26-Sep	92%	358	0	537	0	389	0	584	0	389	584	**A**
9-Oct	40%	98	0	27	0	245	0	68	0	245	68	**A**
16-Oct	70%	295	0	117	0	421	0	167	0	421	167	**A**
29-Oct	76%	37	0	13	28	49	0	17	37	49	54	**B**

Comments

A Lower portion of the river only, from Bridge Pool to Raines Pool.

B Lower portion of the river only, from Bridge Pool to Firehall Pool.

Table 5. Aerial Surveys conducted on the Nanaimo River, 2007

	17-Oct-07				24-Oct-07				30-Oct-07			
	Chinook		Chum		Chinook		Chum		Chinook		Chum	
River Section	**Live**	**Dead**	**Live**	**Dead**	**Live**	**Dead**	**Live**	**Dead**	**Live**	**Dead**	**Live**	**Dead**
Estuary to Cedar Bridge			5000	80			7500	50			8500	1800
Cedar Bridge to Haslam Creek			4200	55			8000	90			16000	1400
Haslam Creek to Bungy Zone			1000	10			700	10			1000	100
Bungy Zone to Borehole	10								Ended Flight at Bungy Zone			
South Fork to First Lake	200				200	20						
First Lake												
Between First and Second Lake												
Second Lake to Green Creek												
Green Creek to Teepee Bridge												
Total	**210**		**10200**	**145**	**200**	**20**	**16200**	**150**			**25500**	**3300**

Table 6. 2007 Nanaimo River Hatchery broodstock collection summary for Fall and Summer run Chinook.

	Fall Chinook			Summer Chinook		
No. Fish	**Female**	**Male**	**Jack**	**Female**	**Male**	**Jack**
Captured	48	52	44	65	61	12
Spawned	34	30	9	58	56	3
Mort	14	17	20	7	3	4
Released	0	5	15	0	2	5
Kelt	0	0	0	0	0	0

Table 7A. Length-frequency of fall run chinook sampled during carcass mark-recapture, lower Nanaimo River, 2007

Length (cm)	Males	Females	Jacks
28	0	0	1
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	1
33	0	0	2
34	0	0	1
35	0	0	1
36	0	0	4
37	0	1	5
38	0	0	6
39	0	0	3
40	0	0	6
41	0	0	8
42	0	0	9
43	0	1	13
44	0	0	11
45	0	0	19
46	0	2	15
47	13	0	0
48	8	1	0
49	6	0	1
50	2	2	0
51	3	1	2
52	2	1	0
53	1	1	0
54	1	0	0
55	0	0	0
56	1	2	0
57	4	2	0
58	3	2	0
59	3	8	0
60	7	2	0
61	2	5	0
62	11	7	0
63	8	6	0
64	4	12	0
65	6	7	0
66	2	4	0
67	1	6	0
68	3	6	0
69	3	2	0
70	3	3	0
71	2	4	0
72	1	6	0
73	3	3	0
74	1	1	0

Table 7A. (continued)

Length (cm)	Males	Females	Jacks
75	0	0	0
76	0	1	0
77	1	2	0
78	0	1	0
Total	107	101	109
Mean Length	60.4	64.3	42.9
Std. Deviation	7.6	6.9	3.9
Adipose Clips	18	34	3
Mark Rate	16.8%	33.66%	2.75%

Table 7B. Length-frequency of summer run chinook sampled during carcass recovery, upper Nanaimo River, 2007.

Length (cm)	Males	Females	Jacks
33	0	0	0
34	0	0	0
35	0	0	0
36	0	0	0
37	0	0	0
38	0	0	1
39	0	0	0
40	0	0	0
41	0	0	0
42	0	0	1
43	0	0	0
44	0	0	2
45	0	0	0
46	0	0	0
47	0	0	0
48	0	0	0
49	0	0	0
50	0	0	0
51	0	2	0
52	1	2	0
53	0	3	0
54	0	1	0
55	1	3	0
56	1	1	0
57	1	2	0
58	1	2	0
59	0	5	0
60	2	0	0
61	0	2	0
62	1	3	0
63	0	3	0
64	0	2	0
65	1	1	0
66	0	0	0
67	2	1	0
68	1	3	0
69	0	3	0
70	0	1	0
71	0	1	0
72	2	2	0

Table 7B. (continued)

Length (cm)	Males	Females	Jacks
73	0	1	0
74	0	1	0
75	0	0	0
76	0	0	0
77	0	0	0
78	0	0	0
79	0	0	0
80	0	0	0
81	0	1	0
Total	16	46	5
Mean Length	64.2	62.4	40.5
Std. Deviation	5.3	7.2	4.9

Table 8A. Summary of age data from fall run chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2007.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2005	2	22	59.5%	1	3.1%	23	33.3%
0.2	2004	3	8	21.6%	18	56.3%	26	37.7%
0.3	2003	4	7	18.9%	13	40.6%	20	29.0%
0.4	2002	5	0	0.0%	0	0.0%	0	0.0%
1.2	2003	4	0	0.0%	0	0.0%	0	0.0%
Total			37	100%	32	100%	69	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 8B. Summary of age data from First Lake summer run chinook sampled during the carcass mark-recapture program, upper Nanaimo River, 2007.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2005	2	1	12.5%	0	0.0%	1	3.4%
0.2	2004	3	6	75.0%	19	90.5%	25	86.2%
0.3	2003	4	1	12.5%	2	9.5%	3	10.3%
Total			8	100%	21	100%	29	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 9. Percentage of the tag application sample recovered on the spawning grounds, by application period and sex, lower Nanaimo River, 2007.

Application Period	Days of Application	Tags Applied				Tagged Recoveries				Percent Recovered			
		Male	Female	Jack	Total	Male	Female	Jack	Total	Male	Female	Jack	Total
18-Oct - 24-Oct	5	27	35	21	83	5	3	4	12	18.5	8.6	19.0	**14.5**
25-Oct - 30-Oct	4	37	29	41	107	6	8	6	20	16.2	27.6	14.6	**18.7**
31-Oct - 5-Nov	4	26	22	24	72	14	6	10	30	53.8	27.3	41.7	**41.7**
6-Nov - 9-Nov	4	17	15	23	55	12	11	8	31	70.6	73.3	34.8	**56.4**
Total	17	107	101	109	317	37	28	28	93	**34.6**	**27.7**	**25.7**	**29.3**

Table 10. Length-frequency of fall run chinook sampled during broodstock collection at the Nanaimo River Hatchery, 2007.

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

Table 10 Cont'd

Total	31	43	41
Mean Length (cm)	55.8	63.0	43.3
Std. Deviation	8.3	5.3	2.7
Adipose Clips	8	32	1
Mark Rate	25.8%	74.4%	2.4%

Table 11A. Summary of age data from fall run chinook broodstock collection, lower Nanaimo River, 2007.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2005	2	46	71.9%	0	0.0%	46	44.2%
0.2	2004	3	16	25.0%	36	90.0%	52	50.0%
0.3	2003	4	2	3.1%	4	10.0%	6	5.8%
Total			64	100%	40	100%	104	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 11B. Summary of age data from First Lake summer run chinook broodstock collection, upper Nanaimo River, 2007.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2005	2	12	46.2%	4	13.3%	16	28.6%
0.2	2004	3	12	46.2%	22	73.3%	34	60.7%
0.3	2003	4	2	7.7%	4	13.3%	6	10.7%
0.4	2002	0	0	0.0%	0	0.0%	0	0.00%
Total			26	100%	30	100%	56	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 11C. Summary of age data from SFN FSC Fishery in the lower Nanaimo River, 2007.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2005	2	14	70.0%	5	35.7%	19	55.9%
0.2	2004	3	5	25.0%	8	57.1%	13	38.2%
0.3	2003	4	1	5.0%	1	7.1%	2	5.9%
0.4	2002	0	0	0.0%	0	0.0%	0	0.00%
Total			20	100%	14	100%	34	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 12. Coded-wire tag data from fall run chinook sampled on the lower Nanaimo River during carcass mark-recapture, 2007.

Recovery Data				**Release Data**				
							Release Date	
Date	**Length (POH) mm**	**Sex**	**E-Label**	**CWT**	**Brood Year**	**Location**	**Start**	**End**
18-Oct-07	625	F	320901E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
18-Oct-07	648	F	320902E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
18-Oct-07	623	M	320903E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
18-Oct-07	624	F	320904E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
19-Oct-07	642	M	620905E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
19-Oct-07	673	M	320906E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
19-Oct-07	632	M	320907E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
19-Oct-07	641	F	320908E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
22-Oct-07	637	F	320909E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
22-Oct-07	681	F	320910E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
23-Oct-07	727	F	320911E	No-Data				
23-Oct-07	631	M	320912E	No-Data				
23-Oct-07	620	F	320913E	No-Data				
24-Oct-07	660	F	320914E	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
24-Oct-07	591	F	321000E	18-55-30	2003	Chemainus	7-May-04	17-May-04
24-Oct-07	625	F	320915E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
25-Oct-07	671	M	320999E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
25-Oct-07	651	F	320917E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
26-Oct-07	629	F	320919E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
26-Oct-07	675	M	320918E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
26-Oct-07	565	F	320920E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
26-Oct-07	606	F	320921E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
26-Oct-07	612	F	320922E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
29-Oct-07	683	F	320998E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
29-Oct-07	647	M	320997E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
29-Oct-07	342	J	320996E	No-Pin				
30-Oct-07	685	M	320925E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
30-Oct-07	625	M	320923E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
30-Oct-07	650	F	320924E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
30-Oct-07	594	F	320926E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
30-Oct-07	536	F	320927E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
30-Oct-07	605	M	320928E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05

Table 12 (Cont'd)

1-Nov-07	680	F	320930E		18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
1-Nov-07	740	M	320931E		18-55-31	2003	Chemainus	17-May-04	18-May-04
2-Nov-07	648	M	320932E		18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
2-Nov-07	626	F	320933E		18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
5-Nov-07	631	M	320934E		18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
5-Nov-07	599	M	320929E		18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
5-Nov-07	365	F	320935E		18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
5-Nov-07	632	F	320936E		18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
5-Nov-07	657	F	320937E		18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
5-Nov-07	566	F	320938E		18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
5-Nov-07	592	F	320939E		18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
6-Nov-07	625	M	320940E		18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
6-Nov-07	587	F	320941E		18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
6-Nov-07	523	F	320942E		Duplicate				
6-Nov-07	635	M	320942E		18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
6-Nov-07	615	F	320943E		18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
7-Nov-07	625	M	320944E		18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
7-Nov-07	614	M	320945E		18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
8-Nov-07	628	F	320946E		18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
8-Nov-07	620	M	320947E		18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
8-Nov-07	602	F	320948E		18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
8-Nov-07	604	F	320949E		18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
9-Nov-07	610	F	320950E		18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
No Label	No Label	No Label	N.A.		18-57-17	2004	Nanaimo	19-May-05	15-Jun-05

Table 13. Snuneymuxw First Nation Food Fish Catch Summary, 2007.

Date	Number of Fish Sampled						Total No. of Fishers Obs.	No. of Fish Obs. Not Biosampled		
	Chinook			Coho						
	Male	Female	Jack	Male	Female	Jack		Chinook	Coho	Chum
20-Aug-07			1							
21-Aug-07			1				10			
25-Aug-07	1		1				6			
30-Aug-07	1	1	1	1			6			
4-Sep-07	1		1							
5-Sep-07		8	1							
6-Sep-07	2	5	6	1	1					
7-Sep-07	3	7	3	2	1		8			
11-Sep-07	2	3	5	1		1	6			
12-Sep-07	2	8	6	3	6	1	10			
13-Sep-07			1	3		1	5			
17-Sep-07		6	4	1		1	6			
18-Sep-07	6	8	7	1	1		11			
19-Sep-07				2			4			
20-Sep-07	11	9	14	3	2		8			
21-Sep-07	1	1	2		2		6			
22-Sep-07	1		3		1		4			
25-Sep-07					1					
26-Sep-07		5	3	2	2		7			
27-Sep-07		2			1		4			
28-Sep-07	1	2	3	1	2			10	10	8
29-Sep-07	1						1			
2-Oct-07							3			
9-Oct-07				2			7			20
11-Oct-07				1			7			11
Total	**33**	**65**	**62**	**23**	**20**	**4**	**112**	**10**	**10**	**28**

Table 14. Coded-wire tag data from chinook sampled on the Snuneymuxw First Nations food fishery on the Nanaimo River in 2007

Recovery Data				Release Data				
							Release Date	
Date	**Length (POH) mm**	**Sex**	**E-Label**	**CWT**	**Brood Year**	**Location**	**Start**	**End**
4-Sep-07	642	M	5034E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
5-Sep-07	650	F	5033E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
6-Sep-07	570	F	5022E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
6-Sep-07	666	F	5023E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
7-Sep-07	740	F	5032E	18-55-31	2003	Chemainus	17-May-04	18-May-04
12-Sep-07	650	M	5031E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
12-Sep-07	666	F	5030E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
12-Sep-07	634	F	5029E	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
12-Sep-07	585	F	5024E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
17-Sep-07	625	F	5025E	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
17-Sep-07	662	F	5026E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
18-Sep-07	618	M	5027E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
18-Sep-07	530	M	5020E	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
18-Sep-07	639	F	5021E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
20-Sep-07	657	M	5028E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
20-Sep-07	625	M	1100E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
21-Sep-07	559	F	1099E	No-Pin				
26-Sep-07	643	F	1096E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05

Table 15. Coded-wire tag data from chinook sampled at Nanaimo River Hatchery, 2007.

Recovery Data				Release Data			Release Date	
Date	Length (POH) mm	Sex	E-Label	CWT	Brood Year	Location	Start	End
21-Oct-07	43	J	372018	18-44-21	2005	Chemainus		
14-Oct-07	57.2	F	372010	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
15-Oct-07	57.2	M	372211	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	62.3	F	372021	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	63.9	F	372035	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
31-Oct-07	61.1	F	372042	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
31-Oct-07	58.1	F	372044	18-57-13	2004	Nanaimo	19-May-05	15-Jun-05
17-Oct-07	60.5	F	37212	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
21-Oct-07	66.1	F	372027	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
28-Oct-07	63.5	M	372029	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
18-Oct-07	62	M	372017	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	56.5	F	372032	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
14-Oct-07	64.6	F	372009	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	63.2	F	372022	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	64.2	F	372031	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	70.2	F	372033	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	51.4	F	372034	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	62.6	F	372039	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
9-Nov-07	60	F	372049	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
18-Oct-07	63.1	F	372015	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	57.3	F	372024	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	64	M	372028	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
6-Nov-07	64.7	M	372046	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
17-Oct-07	65.3	M	37213	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	64.3	M	372019	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	63	F	372023	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	67.7	F	372037	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	64.4	F	372038	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	62.2	F	372040	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
31-Oct-07	63	F	372043	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
1-Nov-07	61.6	F	372045	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
9-Nov-07	60	F	372048	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
7-Oct-07	60	F	372008	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
17-Oct-07	63.8	F	37214	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
18-Oct-07	67.6	F	372016	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	60.9	F	372020	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	64.5	F	372025	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-07	56.1	F	372026	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	69.3	M	372030	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-07	63.6	F	372036	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
31-Oct-07	64.4	F	372041	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05

Table 16. Nanaimo River Hatchery chinook release data for brood years 1997 - 2006.

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site	Run Type
183220	1997	25,240	70,000	36.06	6.67	5/7/1998	5/7/1998	First Lake	Summer
183221	1997	25,173	99,098	25.4	6	5/15/1998	5/15/1998	First Lake	Summer
183223	1997	28,252	43,881	64.38	6.01	5/26/1998	5/26/1998	Nanaimo R.	Fall
182408	1997	10,050	15,610	64.38	6.01	5/26/1998	5/26/1998	Nanaimo R.	Fall
183222	1997	24,824	24,824	100	15.5	7/23/1998	7/23/1998	Jack Point	Fall
-	1998	0	442,830	0	5.1	5/12/1999	5/13/1999	Nanaimo R.	Fall
-	1998	0	165,595	0	5.61	5/28/1999	5/28/1999	First Lake	Summer
-	1998	0	50,411	0	11	6/2/1999	7/8/1999	Jack Point	Fall
184330	1999	25,185	257,394	9.78	4.03	5/17/2000	5/17/2000	First Lake	Summer
184332	1999	25,071	25,071	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
184331	1999	25,185	25,185	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
184333	1999	25,165	25,165	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
184334	1999	25,231	25,231	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
-	1999	0	99,238	0	4.8	5/18/2000	5/18/2000	Nanaimo R.	Fall
184335	1999	25,300	126,422	20.01	5	5/5/2000	5/23/2000	Nanaimo R.	Fall
184336	1999	25,115	125,497	20.01	5	5/5/2000	5/23/2000	Nanaimo R.	Fall
184329	1999	25,175	57,625	43.69	10.34	6/23/2000	6/23/2000	Jack Point	Fall
184363	2000	24,739	207,955	11.9	6.56	5/23/2001	5/24/2001	First Lake	Summer
184552	2000	50,060	105,512	47.44	4.9	4/28/2001	5/29/2001	Nanaimo R.	Fall
184554	2000	50,259	105,931	47.45	4.9	4/28/2001	5/29/2001	Nanaimo R.	Fall
184553	2000	50,254	105,920	47.45	4.9	4/28/2001	5/29/2001	Nanaimo R.	Fall
184362	2000	25,091	51,070	49.13	8.67	6/6/2001	6/6/2001	Jack Point	Fall
184717	2001	25,119	102,917	24.41	4.68	5/9/2002	5/9/2002	Nanaimo R.	Fall
184718	2001	25,355	103,883	24.41	4.68	5/9/2002	5/9/2002	Nanaimo R.	Fall
183205	2001	25,182	25,182	100	5.61	5/14/2002	5/14/2002	Nanaimo R.	Fall
183206	2001	25,237	25,237	100	5.61	5/14/2002	5/14/2002	Nanaimo R.	Fall
184337	2001	25,102	186,187	13.48	5.7	5/16/2002	5/16/2002	First Lake	Summer
184715	2001	25,307	25,307	100	3.78	5/16/2002	5/16/2002	Nanaimo R.	Fall
184716	2001	25,131	25,131	100	3.78	5/16/2002	5/16/2002	Nanaimo R.	Fall
184628	2001	25,119	51,508	48.77	6.62	5/17/2002	5/17/2002	Jack Point	Fall
185527	2002	39,650	39,650	100	20	7/31/2003	7/31/2003	Nanaimo R.	Fall
185528	2002	40,226	40,226	100	10	5/31/2003	5/31/2003	Nanaimo R.	Fall
-	2002	0	173,081	0	7.17	5/6/2003	5/19/2003	First Lake	Summer
-	2002	0	324,204	0	6	5/8/2003	5/21/2003	Nanaimo R.	Fall
-	2003	0	187,214	0	6.93	5/18/2004	5/18/2004	First Lake	Summer
-	2003	0	120,199	0	4.86	5/19/2004	5/19/2004	Nanaimo R.	Fall
185713	2004	29,538	38,922	75.89	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185714	2004	29,559	39,146	75.51	5.0	5/16/2005	6/15/2005	Nanaimo R.	Fall
185715	2004	29,392	38,729	75.89	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185716	2004	29,293	38,792	75.51	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185717	2004	29,124	38,763	75.13	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185802	2004	27,774	36,782	75.51	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185803	2004	24,568	32,535	75.51	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
-	2004	0	154,922	0	8.0	18/05/2005	19/05/2005	First Lake	Summer

Table 16 (continued).

Tag code	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site	Run Type
-	2005	0	174,584	0	5.1	22/05/2006	23/05/2006	Nanaimo R.	Fall
-	2005	0	978	0	2.6	23/05/2006	23/05/2006	Nanaimo R.	Fall
-	2005	0	167,936	0	4.5	24/05/2006	24/05/2006	Nanaimo R.	Fall
-	2005	0	2000	0	3	24/05/2006	24/05/2006	Nanaimo R.	Fall
-	2006	0	421,467	0	--	23/06/2007	29/06/2007	Nanaimo R	Fall
	2006	0	223,745	0	-	17/06/2007	17/06/2007	Nanaimo R	Sum

Table 17. Chemainus River and Cowichan River chinook release data for brood years 2002 - 2006.

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site	Run Type
185129	2002	25,191	55,331	45.53	10	2003/05/15	2003/05/16	Chemainus R	Fall
185130	2002	25,253	55,394	45.59	10	2003/05/15	2003/05/16	Chemainus R	Fall
185131	2002	25,167	40,850	61.61	7	2003/05/15	2003/05/16	Chemainus R	Fall
185132	2002	25,282	40,966	61.71	7	2003/05/15	2003/05/16	Chemainus R	Fall
185530	2003	49,960	79,417	62.91	11.4	2004/05/07	2004/05/17	Chemainus R	Fall
185531	2003	50,283	79,775	63.03	5.44	2004/05/17	2004/05/18	Chemainus R	Fall
-	2004	0	22,164	0.00	9.5	2005/05/17	2005/05/17	Chemainus R	Fall
-	2005	0	25,807	0.00	9.96	2006/05/15	2006/05/15	Chemainus R	Fall
-	2005	0	23,519	0.00	9.58	2006/05/15	2006/05/15	Chemainus R	Fall
-	2005	0	26,934	0.00	9.97	2006/05/15	2006/05/15	Chemainus R	Fall
	2006	0	158,668	0.00	-	2006/05/16	2006/05/16	Chemainus R	Fall
184918	2002	50,091	383,156	13.07	4.5	2003/04/11	2003/04/11	Cowichan R Upper	Fall
184919	2002	50,186	383,877	13.07	4.5	2003/04/11	2003/04/11	Cowichan R Upper	Fall
185013	2002	24,712	257,226	9.61	5.74	2003/05/26	2003/05/26	Cowichan R Upper	Fall
185014	2002	25,128	261,555	9.61	5.74	2003/05/26	2003/05/26	Cowichan R Upper	Fall
185015	2002	25,102	261,282	9.61	5.74	2003/05/26	2003/05/26	Cowichan R Upper	Fall
185016	2002	25,197	288,668	8.73	6	2003/05/27	2003/05/27	Cowichan R Lower	Fall
185052	2002	25,134	99,918	25.15	7.36	2003/05/28	2003/05/28	Cowichan Bay	Fall
185412	2003	25,144	99,887	25.17	6.54	2004/05/26	2004/05/26	Cowichan Bay	Fall
185660	2003	25,111	197,202	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185661	2003	25,110	197,194	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185662	2003	25,124	197,304	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185663	2003	25,051	196,731	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185701	2003	25,168	219,733	11.45	5.3	2004/05/20	2004/05/20	Cowichan R Upper	Fall
185702	2003	24,863	219,261	11.34	5.3	2004/05/20	2004/05/20	Cowichan R Upper	Fall
185703	2003	24,987	219,252	11.40	5.3	2004/05/20	2004/05/20	Cowichan R Upper	Fall
185704	2003	25,029	98,411	25.43	6.65	2004/05/11	2004/05/11	Cowichan R Lower	Fall
-	2003	0	116,307	0.00	2.41	2004/11/08	2004/11/19	Cowichan L Tributaries	Fall

Table 18A. Total adult chinook returns to the Nanaimo River, 1975-2007.

	Natural Spawners		Hatchery Broodstock		First Nations	Total
Year	Fall	Summer	Fall	Summer[1]	Food Fish Catch	Returns
1975	475	-	-	-	15	490
1976	880	-	-	-	50	930
1977	2380	-	-	-	60	2420
1978	2125	-	-	-	40	2165
1979	2700	-	41	-	23	2764
1980	2900	-	82	-	200	3182
1981	210	-	15	-	100	325
1982	1090	-	62	-	21	1173
1983	1600	-	240	-	30	1870
1984	3000	-	178	-	50	3228
1985	650	-	264	-	185	1099
1986	700	-	258	-	190	1148
1987	400	-	357	-	50	807
1988	650	-	429	-	0	1079
1989	1150	-	402	-	0	1552
1990	1275	-	122	-	0	1397
1991	800	-	135	-	0	935
1992	800	-	377	-	0	1177
1993	850	-	528	-	0	1378
1994	400	-	280	-	10	752
1995	1592 [2]	100	311	75	50	2128 [3]
1996	990 [2]	600	257	167	335	2349 [3]
1997	638 [2]	600	52	129	0	1419 [3]
1998	1011 [2]	200	251	89	0	1551 [3]
1999	1920 [4]	500	242	179	70	2911 [3]
2000	596 [6]	450	184	162	126	1518 [3]
2001	1277 [6]	250	165	169	188	2049 [3]
2002	946 [6]	432	212	205	213	2008 [3]
2003	1378 [7]	393	82 [8]	131 [8]	50	2034 [3]
2004	1891 [9]	200	119 [10]	106	220	2549 [11]
2005	1239 [9]	201	186	122	950	2705 [11]
2006	1723 [9]	672	220	168	580	3363 [11]
2007	2222 [9]	220 [9]	100	126	225	2893[11]

[1] Ocean type only.
[2] Count at enumeration fence minus broodstock removal above the fence.
[3] Fall natural spawners plus fall broodstock removal below the fence, Native food fish catch and summer run estimate.
[4] Mark recapture Petersen estimate.
[5] Mark recapture estimate plus fall broodstock removal, Native food fish catch and summer run estimate.
[6] Adjusted fence count minus broodstock removal above the fence.
[7] Extrapolated fence count, plus adult/jack adjustment, minus broodstock removals above the fence.
[8] Does not include fish released during high water.
[9] AUC estimate minus broodstock removals.
[10] 107 fish from Nanaimo River Mainstem and 12 from Napoleon Creek.
[11] AUC estimate plus summer estimates plus broodstock removals plus Native food fish catch.

Table 18B. Total jack chinook returns to the Nanaimo River, 1995-2007.

	Natural Spawners		Hatchery Broodstock		First Nations	Total
Year	Fall [1]	Summer [2]	Fall	Summer[1]	Food Fish Catch	Returns [3]
1995	3236	200	88	N/A	-	3524
1996	891	-	72	28	-	991
1997	173	-	24	12	-	209
1998	599	-	30	6	-	635
1999	280 [4]	-	3	21	-	304 [5]
2000	992	-	10	6	-	1008
2001	1385 [6]	-	19	27	-	1431
2002	644 [6]	-	15	15	-	674
2003	772 [7]	-	48	8	-	828
2004	190 [8]	-	30	17	-	255
2005	487 [8]	16	58	91	-	654
2006	2716 [8]	120 [9]	66	8	-	2910
2007	1931 [8]	12	44	12	62	2061

[1] Count at enumeration fence minus broodstock removal above the fence.

[2] First Lake summer run only.

[3] Natural spawners plus fall broodstock removal below the fence, Native food fish catch and summer run estimate.

[4] Mark recapture Petersen estimate.

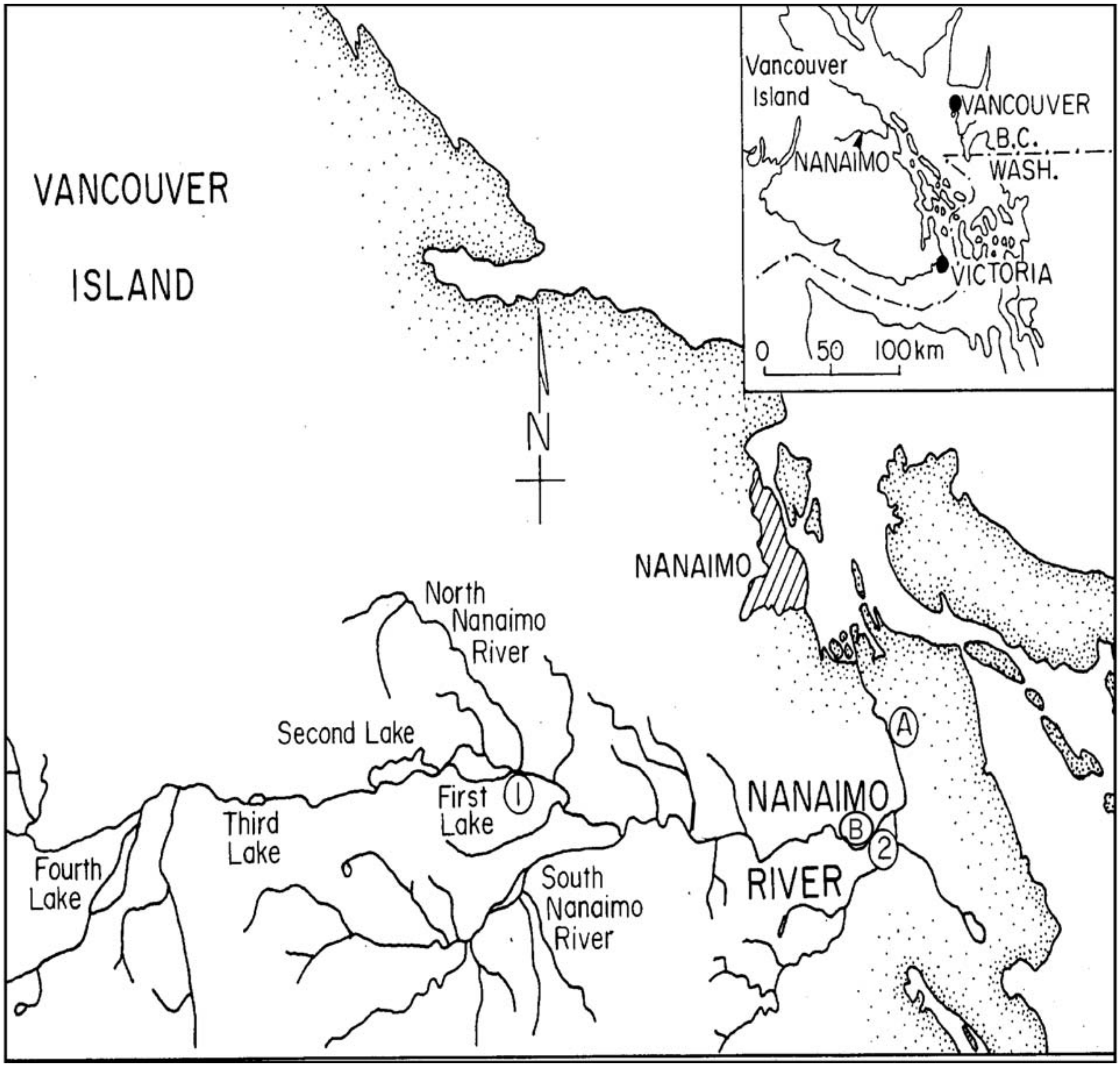
[5] Mark recapture estimate plus fall broodstock removal, Native food fish catch and spring run estimate.

[6] Adjusted fence count minus broodstock removal above the fence.

[7] Extrapolated fence count, plus adult/jack adjustment, minus broodstock removals above the fence.

[8] AUC estimate minus broodstock removals.

[9] Swim Survey Estimate



LEGEND:

1 Hatchery Release Site
2 Hatchery Release Site
A Enumeration Fence Site (removed 2003)
B Downstream Fry Trapping Site

Figure 1. Nanaimo River study area.

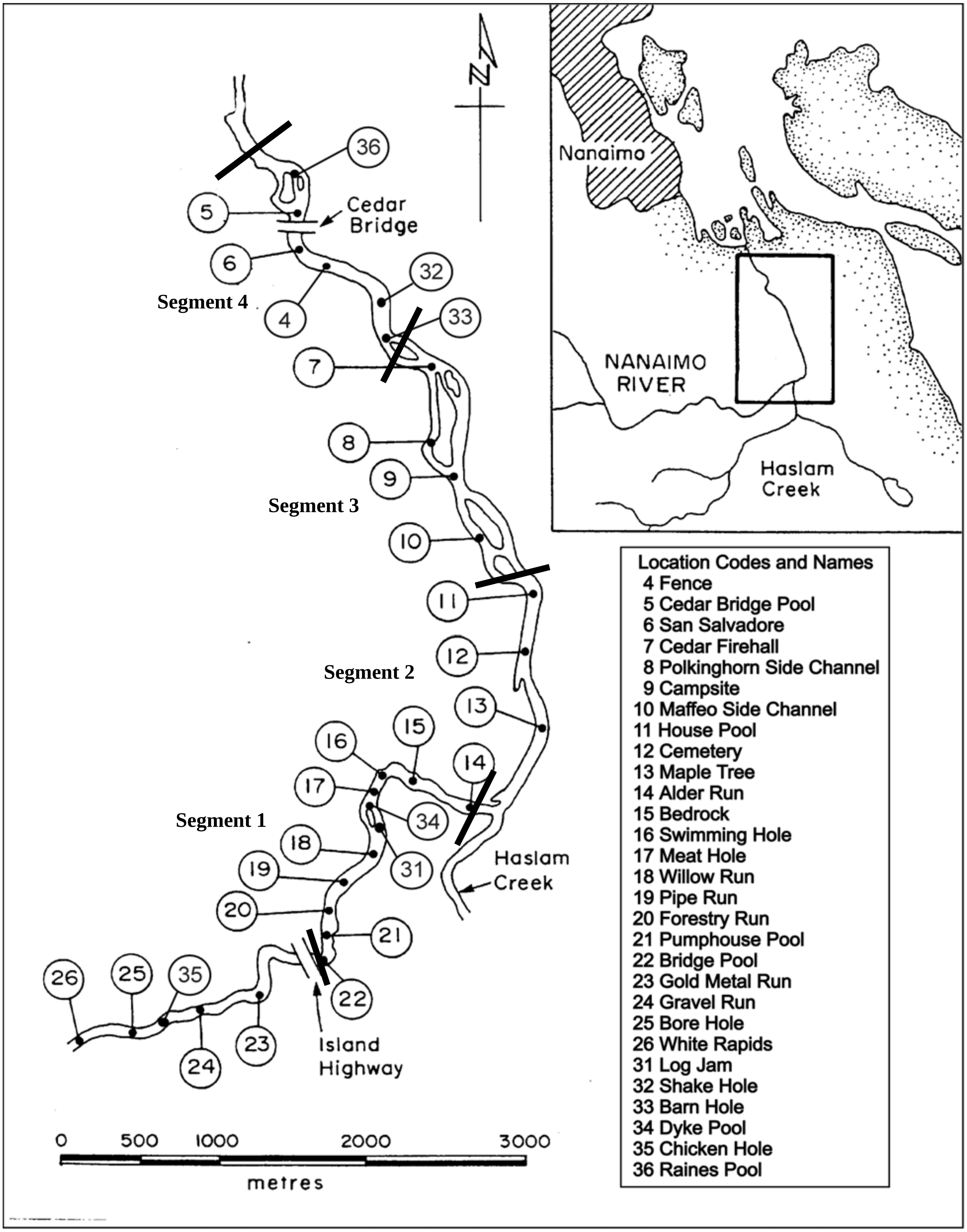


Figure 2. Swim survey and mark-recapture sites on the lower Nanaimo River.

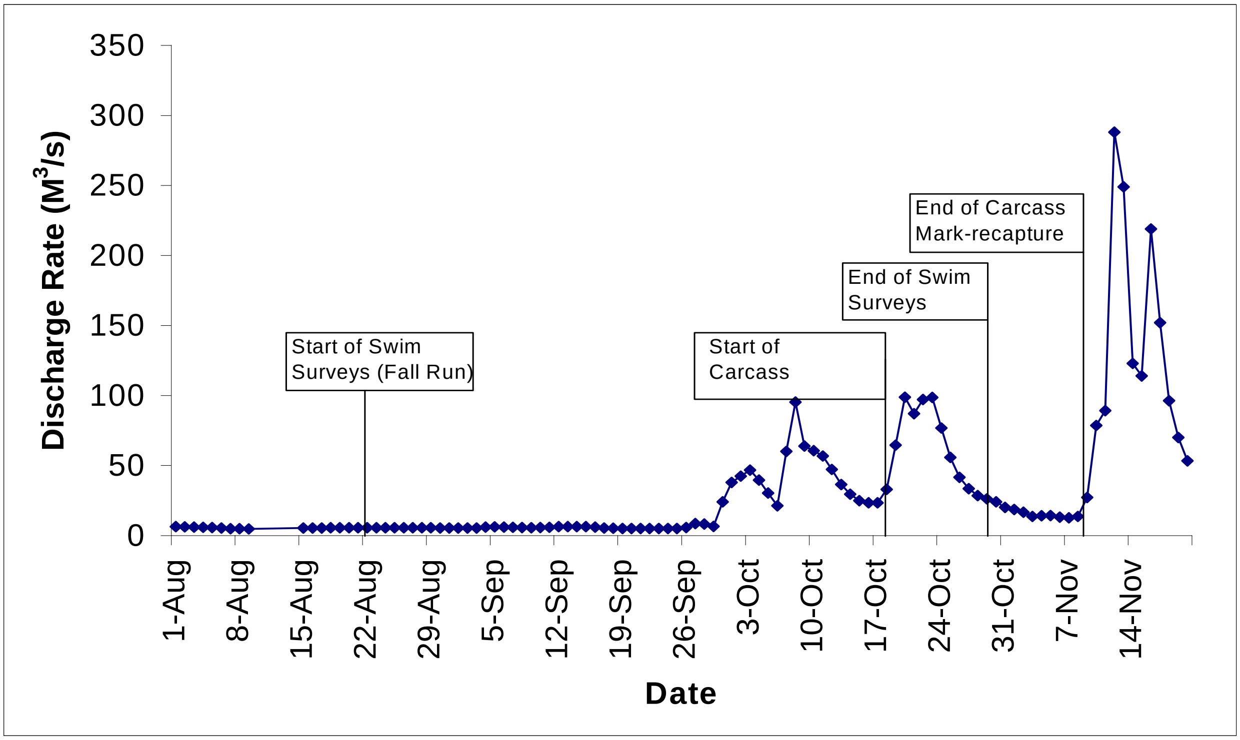


Figure 3. Daily Nanaimo River Discharge (m^3/s) during the fall run chinook season 2007. Discharge data are preliminary and subject to revision.

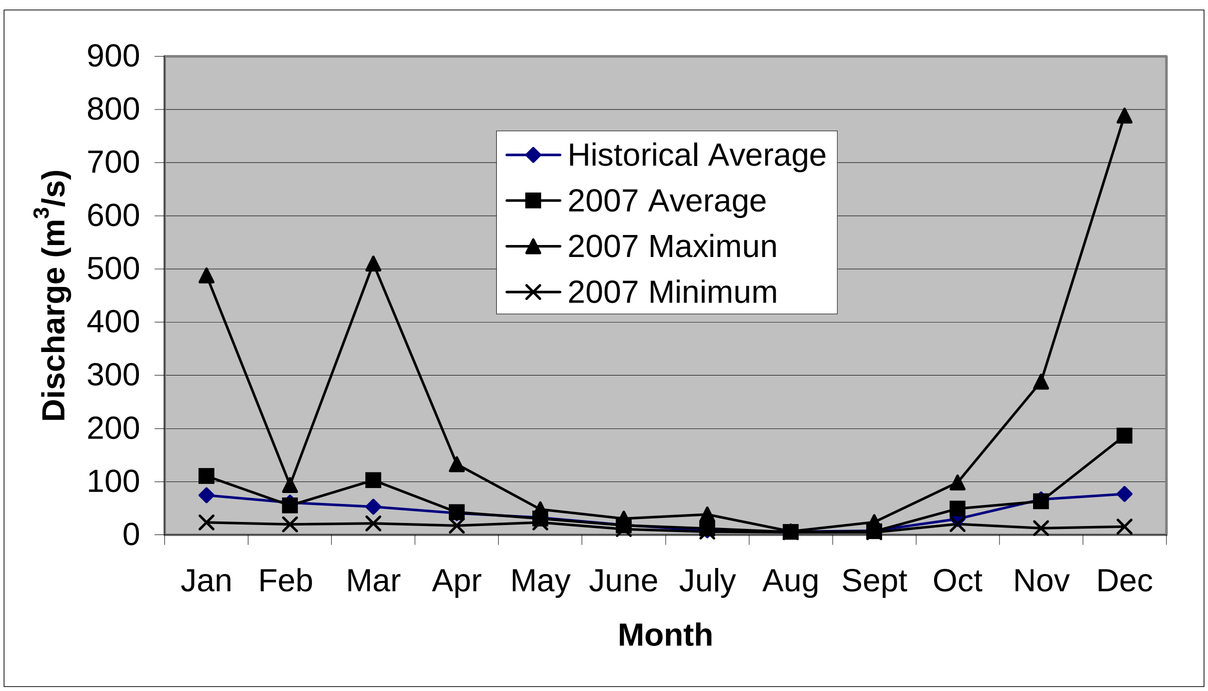


Figure 4. Monthly Nanaimo River discharge (m^3/s) in 2007 along with historic (1965-2006) monthly mean.

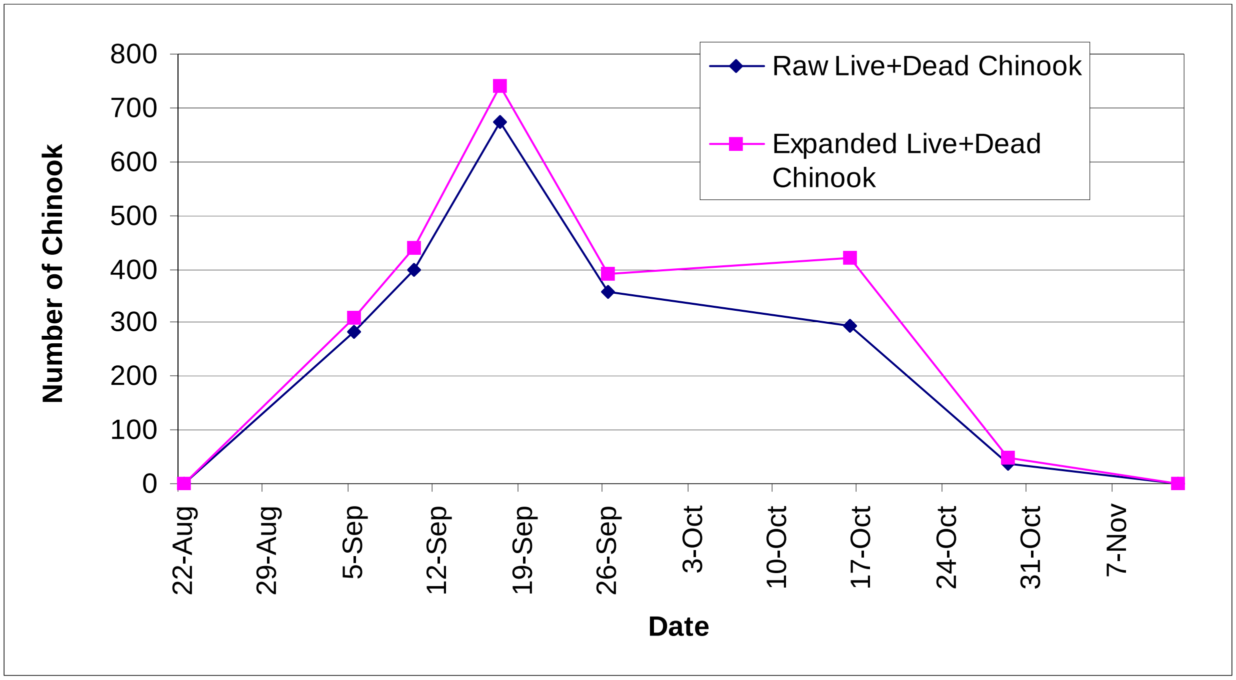


Figure 5. Expanded (for observer efficiency) and raw swim survey counts, lower Nanaimo River in summer/fall 2007.

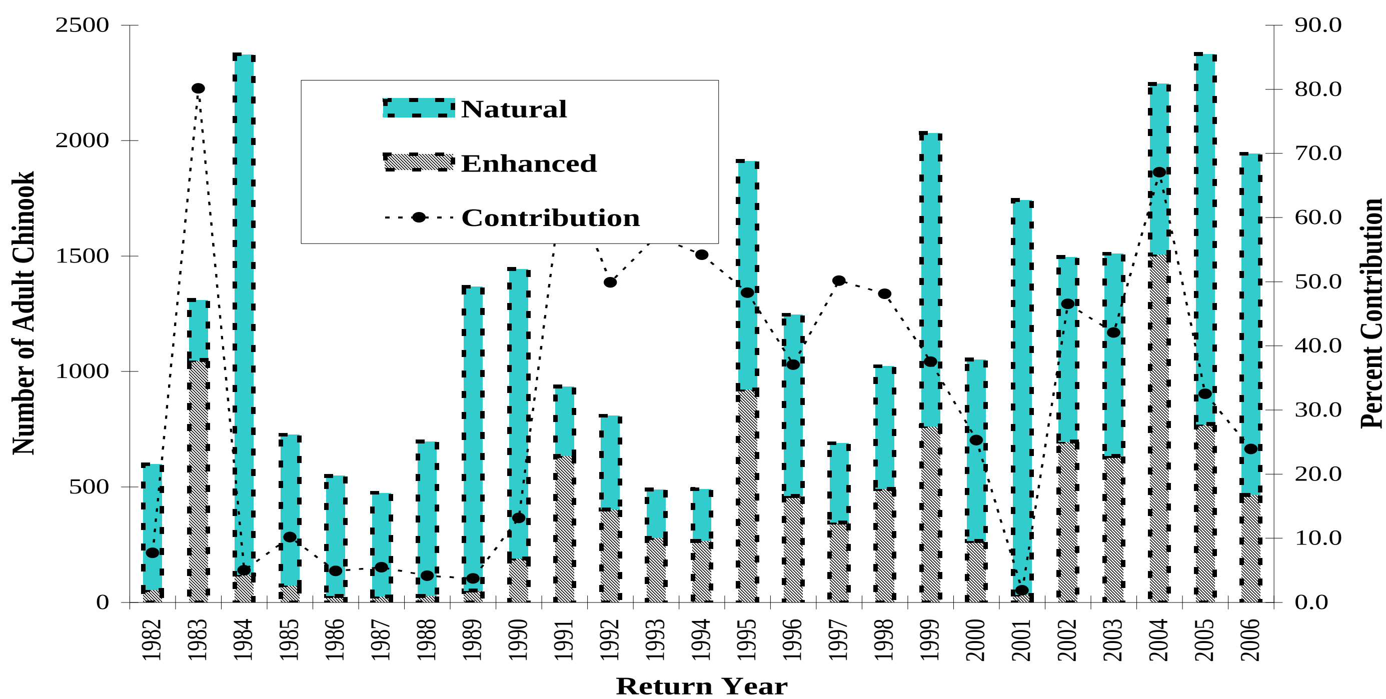


Figure 6. Annual natural and enhanced contributions to fall run chinook escapement, Nanaimo River 1982-2006

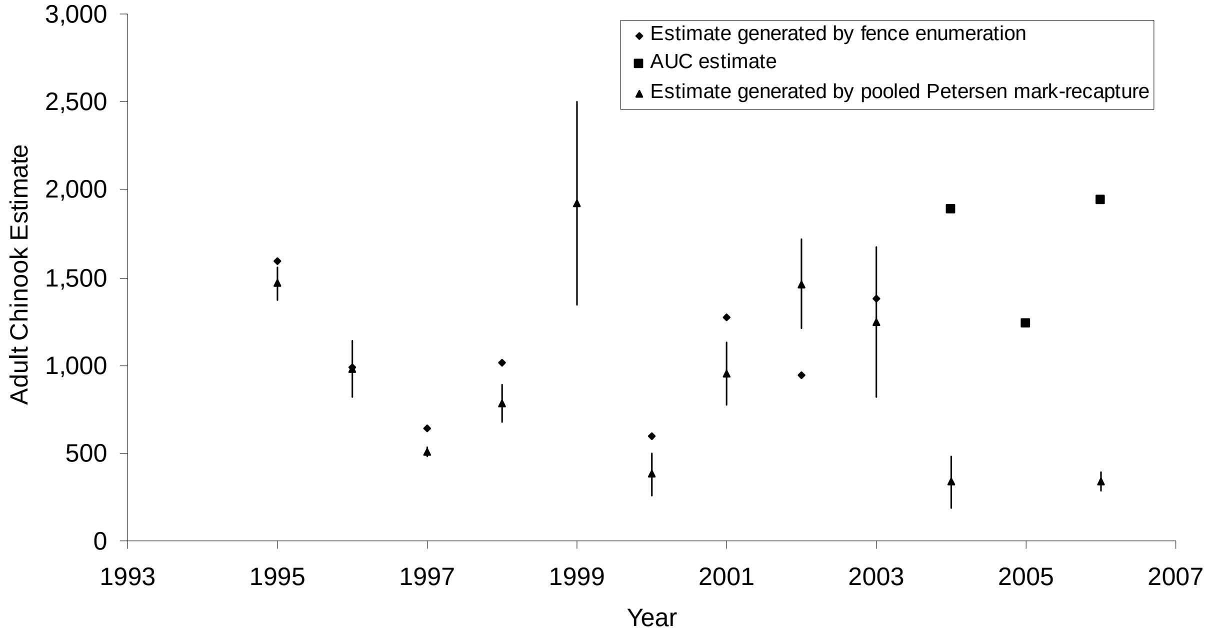


Figure 7. Annual comparisons of fall run adult chinook population estimates generated by fence information, AUC, and mark-recapture pooled Petersen calculations (with 95% confidence intervals), lower Nanaimo River, 1995 - 2006.

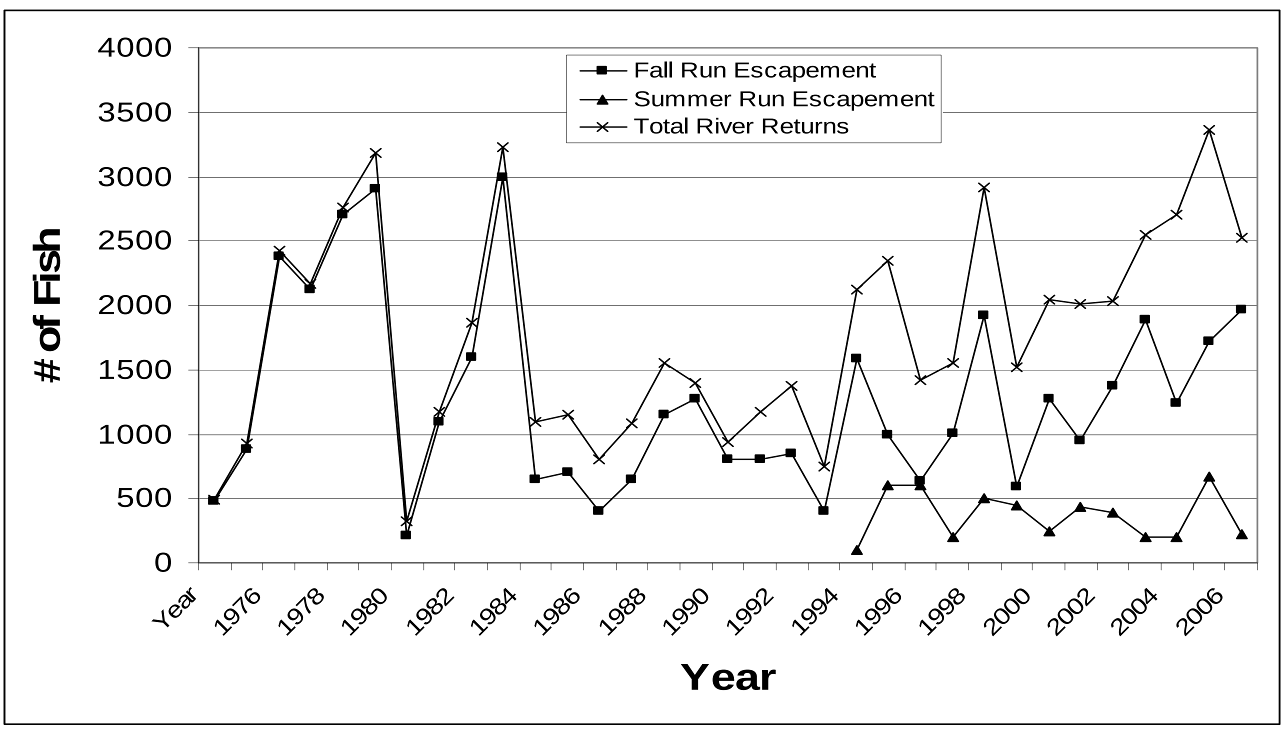


Figure 8. Annual adult fall and summer run chinook escapements in the Nanaimo River 1975-2007