Adult Chinook Escapement Assessment Conducted on the Nanaimo River During 2006

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ADULT CHINOOK ESCAPEMENT ASSESSMENT CONDUCTED ON THE NANAIMO RIVER DURING 2006

by

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In 2006, 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 both fall run and First Lake summer 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 spring and summer run chinook by aerial and swim 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 2,523 of which 1,723 spawned naturally. A Petersen mark-recapture estimate between Wolf Creek and First Lake plus data compiled during hatchery broodstock collection were used to estimate the naturally spawning population of the First Lake summer run chinook to be 672 fish and the total return to be 840 fish. Total return of all adult chinook to the Nanaimo River system in 2006 was 3363 fish.

RÉSUMÉ

Graf, G. W.F. and E. W. Carter. 2007. Adult chinook escapement assessment conducted on the Nanaimo River during 2006. Can. Manuscr. Rep. Fish. Aquat. Sci. 2792: 53 p.

En 2006, 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 et de la remonte de quinnats de sumer du lac First 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 la rivière Nanaimo inférieure; iii) dénombrer les quinnats de printemps et sumer 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 2523 individus, dont 1723 ont frayé naturellement. Nous avons utilisé les estimés obtenus selon la méthode de Petersen de marquage-recapture entre le ruisseau Wolf et le lac First, ainsi que l’information recueillie lors du prélèvement de reproducteurs d’écloserie, pour estimer les effectifs de la population de quinnats de sumer qui se reproduisent naturellement dans le lac First. Ce nombre se chiffrait à 672 individus, et la remonte totale à 840 individus. En 2006, la remonte totale de quinnats dans le réseau de la rivière Nanaimo se chiffrait à 3363 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 along with the 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 Georgia Strait chinook with the unique distinction of monitoring one fall and two spring runs. In 2006, DFO, Science Branch, in conjunction with Snuneymuxw First Nation and the Nanaimo River Hatchery continued to operate a carcass mark-recapture and swim survey program to collect information on chinook escapements.

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 in addition to a fall run stock returning to the Nanaimo River (Figure 1).

The two spring run stocks enter the river from 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 outmigrating to the estuary (Healey 1980, Blackman 1981, Nagtegaal and Carter 2000).

The First Lake summer run spawns within the first 1.6 kilometres downstream of the First Lake outlet to the Wolf Creek junction pool (Healey and Jordan 1982, Hardie 2002), with the peak of spawning 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 outmigrate 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 run 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 outmigrate 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 2006, a total of 263,669 fall run chinook fry and 154,922 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 2005, 75.6% of fall run chinook fry carried coded-wire tags. No CWT tagged chinook fry were released in 2006.

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 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).

This report presents the results of the study completed during 2006. The objectives 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 First Nations 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 and sampling coded-wire tag (CWT) recoveries, and
6. Generating an area-under-the-curve (AUC) estimate through swim surveys in the lower Nanaimo River.

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 was used to generate a chinook population estimate for both upper and lower river stocks, while an AUC estimate was also generated using swim survey information in the lower river. 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 both the fall run and First Lake summer run adult and jack chinook. The mark-recapture also provided information on length frequencies, age compositions, and sex composition. CWT data were also collected to be used 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 aluminium 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 analysed 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. Chinook fry released from this hatchery 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 spawned between the Island Highway Bridge and the Cedar Bridge. Carcass mark-recapture in the upper portion of the Nanaimo River watershed targeted First Lake summer run chinook which spawned in a two-kilometre stretch of river, between the outlet of First Lake and the Wolf Creek outlet.

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 not known, 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 biases.

Finding sampling biases usually results in the use of a stratified estimator; however, Schubert (2000) compared the performance of several mark-recapture population estimators for a

[1] Ketchum Manufacturing Ltd., Ottawa, Canada

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 but that 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 as well as to assess spawning distribution throughout select portions of the river. Swim surveys were normally carried out using three swimmers staying abreast of each other while moving downstream. Swimmers combined individual counts, which were recorded by pre-defined localities in the river (Figure 2).

Swim surveys conducted in lower portions of the Nanaimo River Watershed between 7 September and 29 October were used to calculate an area-under-the-curve (AUC) estimate for fall run chinook (English et al. 1992; Irvine et al. 1993). In the lower portions 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. Through a tagging process this year a survey life statistic of 11.53 days was generated. Observer efficiency accounts for fish missed by observers. Observer efficiency was generally good during swims in 2006, ranging from 75% - 95%.

While there was an insufficient number of swims conducted in the upper Nanaimo River to calculate an AUC estimate, we were able to complete five swims in that part of the watershed. Through these counts, a peak live plus dead chinook estimate was determined.

AERIAL SURVEY

Three aerial surveys were conducted throughout the Nanaimo River Watershed, which were focussed on enumerating chinook and chum salmon. The helicopter, a Eurocopter A-Star, was flown at low altitude, approximately 300 feet (~91.4 m), to aid in visibility as well as the identification of salmon species. Counts were made by river pool or river section and combined to obtain a final estimate. Two counters were employed for the aerial survey. Flights took place on 29 September, 17 October and 1 November. The first flight covered the watershed from the estuary to Second Lake-Green Creek. The second flight covered from the estuary to the Island

Highway bridge and the upper watershed from Green Creek to Teepee Bridge. The final flight covered the estuary to First Lake.

FIRST NATIONS FOOD FISHERY

In previous years 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 2006, the catch estimate was again provided by the SFN guardian. Another SFN member who was familiar with the fishery was 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

The low flow 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 utilised 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 was initiated by the B.C. Ministry of Environment (BCMOE) in June 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 kilometre 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 river banks. 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

The carcass mark-recapture program was divided into two recovery areas, the lower Nanaimo River and the upper Nanaimo River. 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 19 October, occurred over 14 days, and was discontinued on 13 November 2006. 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 scales were read.

Age information provided from scale data was preferred as four adults were found to be incorrectly identified. Two 487 mm POH length males, captured on 24 October and 2 November, a 483 mm male captured on 27 October, and a 496 mm male captured on 24 October, all had European scale 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 105 male, 59 female, and 122 jack chinook were tagged and released in the lower Nanaimo River (Table 2A). Tagged carcasses recaptured include 47 (41%) males, 31 (27%) females, and 37 (32%) jacks. Using the Petersen estimator, the total adult lower Nanaimo River fall run chinook population estimate was 345 fish (95% CI: 290 – 399) (Table 3A).

Potential Biases

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

1. Temporal Bias: Temporal bias in the mark and recovery data was analysed by stratifying the mark and recovery rates into four equal application and recovery periods. A highly significant temporal bias was found between application and recovery periods (Chi-Square = 39.39; $p \leq 0.001$).

Temporal bias in the marking sample was analyzed by stratifying the marking rates into four application periods. In this case a significant statistical difference in the marking rate over time was observed (Chi-Square = 19.51; $p \leq 0.01$).

Temporal bias in the recovery sample was examined by stratifying the marking rates into four application periods. No significant statistical difference in the recovery rates over time was found (Chi-Square = 2.87; $p \leq 1$).

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 = 3.33; p = $\leq$ 0.20).

3. Size Bias: Size related bias was examined by comparing the mean POH lengths of unrecovered 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 = -1.23; p>0.1, t = 0.12; p>0.1, and t= -0.57; p>0.1 for males, females, and jacks respectively).

Upper Nanaimo River

The upper Nanaimo River carcass mark-recapture commenced on 17 October, occurred over eight days, and was discontinued on 3 November 2006. Similar to the lower Nanaimo River mark-recapture, male chinook observed were designated adult or jack based on size. The ability to differentiate males based on age was utilized once scales were read. The only discrepancy between scale age and length was a 525 mm POH length male, captured on 18 October, with a European scale age of 0.1. This fish was re-categorized as a jack chinook.

During this sampling period 124 male, 99 female, and 22 jack chinook were tagged and released in the upper Nanaimo River (Table 2B). Tagged carcasses recaptured include 65 (47%) males, 59 (43%) females, and 11 (8%) jacks and two (2%) of unknown sex. Using the Petersen estimator, the total adult First Lake summer run chinook population estimate was 401 fish (95% CI: 355 – 448) (Table 3B).

Potential Biases

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

1. Temporal Bias: Temporal bias in the mark and recovery data was analysed by stratifying the mark and recovery rates into four equal application and recovery periods. A highly significant temporal bias was found between application and recovery periods. (Chi-Square = 39.39; $p \leq 0.001$).

Temporal bias in the marking rates was analyzed by stratifying the rates into four application periods. There was no statistical difference in the marking sample over time. (Chi-Square = 0.4; $p \leq 1$).

Temporal bias in the recovery rates were was examined by stratifying the recovery rates into four application periods. No statistical difference in the recovery rate over time was found (Chi-square = 4.1; $p \leq 0.2$).

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 = 0.49; p = ≤ 0.10)

3. Size Bias: Size related bias was examined by comparing the POH means lengths of marked chinook and recovered chinook by sex. No significant size bias was evident between the marked and recovered samples of adult male, female or jack chinook (Students t-test: $t = 1.59$; $p > 0.1$, $t = -0.33$; $p > 0.1$, and $t = 0.38$; $p > 0.1$ for males, females, and jacks respectively).

SWIM SURVEYS

In 2006, a total of ten swim surveys were conducted in the lower portion of the Nanaimo River and five swims were conducted in the upper Nanaimo River to determine chinook abundance and distribution (Table 4). Swims began on 17 July and ended on 30 October. All lower river swims started at the Island Highway Bridge pool. The first two swims on 17 July and 27 July were focused on examining upper Nanaimo River spring and summer run chinook. Three swims on 24 August included portions of the Nanaimo River inhabited by spring, summer, and fall run chinook stocks.

Seven swims from 24 August to 10 October covered the lower portions of the river only, from Bridge Pool to Raines Pool. A final upper river swim occurred on 12 October, covering portions of the river from First Lake to Wolf Creek. The final three lower river swims, occurring from 16 October until 30 October, were targeted at 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.

Swim surveys conducted in lower portions of the Nanaimo River Watershed between 7 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 area known as San Salvadore. 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. A start date of 20 August was chosen as a time just before fall run chinook entered the survey area (H. Bob. Nanaimo River Salmonid Enhancement Project Co-Manager, Nanaimo River Stewardship Society, 2775 Rugby Rd, Nanaimo, B.C., V9G 1A1. pers. comm.). 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 14 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, for example, deep pools or log jams. Observer efficiency was generally good during swims in 2006, ranging from 75% - 95%.

The calculated AUC estimate for fall run adult chinook in the lower Nanaimo River is 1943 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 2782 jack chinook. Please note that 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 but the swim survey data were considered the most reliable. The final swim conducted on 12 October produced counts of 571 adult and 102 jack chinook. These were expanded to 672 and 120, respectively (Table 4).

AERIAL SURVEY

Three aerial surveys were conducted to enumerate spawning chinook, on 29 September, 17 October, and 1 November. The primary purpose of the flights was to look at chinook spawning distribution as well as to enumerate chum salmon in the Nanaimo River. The first flight enumerated chinook and chum from the estuary to Second Lake-Green Creek. All flights occurred under clear conditions during low 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 flight yielded a chinook count of 559 live adults and 82 chum within the Nanaimo River. The second flight on 17 October saw 150 live chinook and 7 dead chinook in the lower river plus 21 live and 18 dead chinook in the river above Second Lake. The third flight on 1 November found 35 live chinook, 40 chinook mortalities in the lower river, and 37 live chinook and 24 dead in the upper river below First Lake (Table 5).

FIRST NATIONS FOOD FISHERY

There is no Snuneymuxw First Nation (SFN) fishery which specifically targets chinook salmon, however, an in-river chum gillnet fishery takes place, usually in October, to provide food, social, and ceremonial fish for the SFN. The target species for this fishery is chum; however, chinook are incidentally caught and kept. This fishery is held in a one kilometre area downstream of the Cedar Bridge and monitored by the SFN Fisheries Guardians. In 2006, the adult chinook catch was estimated to be 580 adults. No catch estimate for jack chinook was provided.

In previous years, 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 2006, a SFN member who was familiar with the fishery was hired to go to the river on a regular (near daily) basis and collect biological data from the fishers' catch. The sample size was not sufficient to statistically compare the size, age, or mark rates with those fish sampled during the carcass mark-recapture program or the hatchery broodstock. Sampling took place over 19 days from 23 September to 24 October. The number of chinook sampled includes 12 adult males, 12 females and 14 jacks (Table 13).

Two chinook were observed caught but not bio-sampled. A total of 53 coho were also sampled. Jack chinook lengths ranged from 318 mm to 466 mm (mean length = 438 mm), adult males from 473 mm to 772 mm (mean length = 614 mm), and females from 641 mm to 760 mm (mean length = 698 mm). In addition, the sampler observed 13 coho and 693 chum salmon caught but not sampled. A subsample of scales revealed that there were five two-year olds (50 %), three three-year olds (30 %) and two four-year olds (20 %). All chinook sampled were found to be ocean-type chinook fry as no scales exhibited over-wintering in fresh water.

Of the 38 chinook sampled, 14 were missing adipose fins indicating possible coded-wire tags. Their heads were sent to the lab for CWT detection and decoding. All contained coded-wire tags and 13 of these were reared in the Nanaimo River from the 2004 brood year and released in 2005. The fourteenth was a chinook from the Chemainus River 2003 brood year and released in 2004 (Table 14).

HATCHERY COMPONENT

During 28 September to 25 October, the Nanaimo River Hatchery's field records show 100 male, 107 female, and 43 jack fall run chinook were collected from lower portions of the Nanaimo River (Table 6). Through 02 October to 04 October, 95 male, 73 female and 8 jack First Lake summer run chinook were recorded as being captured in the First Lake area. No Upper Nanaimo River spring run chinook were removed for hatchery broodstock.

BIOLOGICAL DATA

During the lower Nanaimo River spawning ground carcass mark-recapture, 113 male, 59 female, and 114 jack chinook carcasses were sampled and measured for post orbital-hypural length (Table 9A). The lengths of adult male chinook carcasses ranged from 48.0 cm to 86.0 cm and averaged 60.9 cm. Adult female carcasses ranged from 37.0 cm to 78.0 cm and averaged 63.4 cm. Jack chinook carcasses ranged in lengths from 32.0 cm to 47.0 cm and averaged 41.9 cm (Table 7A).

A total of 15 (21%) male, 9 (13%) female, and 47 (66%) jack chinook were missing adipose fins. Age analysis of male chinook revealed that 62% were two years old, 31% were three years old, and 7% were four years old (Table 8A). Analysis of female chinook scales indicated that 12.5% were two years old, 50% were three years old, 31.3% were four years old, and 6.2% were five years old. One four-year old male and one four-year old female chinook had scales exhibiting over-wintering in freshwater.

During the upper Nanaimo River spawning ground carcass mark-recapture, 127 male, 99 female, and 18 jack chinook carcasses were sampled and measured for post orbital-hypural length (Table 9B). The lengths of adult male chinook carcasses ranged from 48.8 cm to 82.6 cm and averaged 60.5 cm, female carcasses ranged from 49.5 cm to 85.6 cm and averaged 61.9 cm, and jack carcasses ranged from 32.7 cm to 43.0 cm and averaged 37.7 cm (Table 7B). No upper river chinook were found missing an adipose fin.

Age analysis of male chinook revealed that 41.7% were two years old, 58.3% were three years old, and none were four years old or older (Table 8B). Analysis of female chinook scales yielded that 2.6% were two years old, 94.7% were three years old, and 2.6% 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: $t = 0.17$; $p>0.05$), or between the mean lengths of lower and upper river female chinook ($t = 1.48$; $p>0.05$). There was however, a highly significant difference between the mean lengths of lower and upper river jack chinook (Student's t-test: $t = 4.99$; $p < 0.0001$).

A total of 27 adult male, 84 female, and 76 jack fall run chinook were randomly collected from hatchery broodstock, measured for post orbital-hypural lengths, scale sampled and examined for adipose-clipped fins. Adult male chinook ranged from 51 cm to 76 cm and averaged 59 cm. Female chinook lengths ranged from 47 cm to 82.3 cm and averaged 62.5 cm, jack chinook ranged from 29.5 cm to 47.8 cm and averaged 41.2 cm (Table 10).

Eight (9%) adult males, 25 (29%) females, and 54 (62%) jacks were found to be missing adipose fins (Table 10). Fish identified as male chinook were 74.7% two years old, 22.2% three years old and 3.0% four years old. Female chinook were 76.5% three years old, 19.1% four years old and 4.4% five years old (Table 11A). Chinook taken for broodstock from the upper Nanaimo River were aged as follows; males - 64.8% two years old, 31% three years old, and 4.2% four years old; females - 77.1% three years old, 18.6% four years old, and 4.3% five years old (Table 11B). All summer run chinook were found to be ocean-type chinook fry as no scales exhibited over-wintering in freshwater.

When comparing mean lengths of female fall run chinook recovered from the lower Nanaimo River spawning grounds and female hatchery broodstock samples, no statistical difference was apparent (Student's t-test: $t = 1.58$; $p>0.01$). Comparisons between mean lengths of female First Lake summer run chinook recovered from the upper Nanaimo River spawning grounds and chinook sampled from hatchery broodstock also yielded no significant difference (Student's t-test: $t = -1.76$; $p>0.01$). T-test comparisons between mean lengths of male chinook sampled at the hatchery and male chinook recovered in both lower and upper carcass recapture programs revealed no significant difference in mean length between the two groups (Student's t-test: $t = 0.83$; $p>0.01$, and $t = -0.69$; $p>0.01$, respectively).

A significant difference was found between the mean lengths of jack chinook sampled at the hatchery and those from the upper river carcass mark-recapture program (Student's t-test: $t = -3.19$; $p < 0.001$). There was no significant statistical difference between the mean lengths of jacks sampled at the hatchery and those from the lower Nanaimo River carcass recapture program (Student's t-test: $t = 1.21$; $p>0.01$).

A highly significant difference was found between the mean lengths of female and male broodstock sampled at the Nanaimo River hatchery (Student's t-test: $t = -3.44$; $p<0.0001$). Females were significantly larger.

A comparison between female chinook mark rates obtained from lower Nanaimo River carcass mark-recapture and fall run broodstock collection did not yield a significant difference (Chi-Square = 4.821; $p<0.01$). However, when comparing males (jacks and adults combined) obtained from fall run chinook collected in the carcass mark-recapture and for broodstock, a statistically significant difference was apparent (Chi-Square = 7.092; $p<0.01$). 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 found to have been missing an adipose fin.

Eighty-eight chinook carcasses recovered on the spawning grounds were found to have been missing adipose fins with 62 of these fish containing coded-wire tags (Table 12). All adipose-clipped fish were recovered in the lower Nanaimo River. Forty-eight chinook identified as having a CWT were reared at the Nanaimo River Hatchery, with one chinook released during the 2002 brood year and 47 released during the 2004 brood year. The remaining 14 chinook were of Chemainus River origin, raised at the Nanaimo River Hatchery; with 13 released into the Chemainus River in May 2004 and one in May of 2002.

The Nanaimo River Hatchery noted 87 chinook collected for broodstock purposes to be missing adipose fins, denoting a possible CWT. Of the 87 fall run chinook heads sent in for analysis, 82 were found to contain CWT's. Of these, 58 (70.7%) were found to have been Nanaimo River chinook fry and 24 (29.3%) were of Chemainus River origin (Table 14). Of the 58 Nanaimo River fall run chinook, 52 (89.5%) were 2004 brood year, three (5.25%) were from the 2002 brood year and three (5.25%) were from the 2001 brood year (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 – 2005, see Table 15.

For fry releases to the Chemainus River and Cowichan River Watershed, brood years 2002 – 2005, see Table 16.

Otoliths were collected and analysed from 100 carcasses from both the lower (48 male, 31 female, 21 jack) and upper (59 male, 36 female, 5 jack) river chinook. All were readable and none thermally marked. (J. Till, Stock Assessment Technician, DFO, 3225 Stephenson Point Road, Nanaimo, B.C., pers. comm.). The Nanaimo River Hatchery Staff did not collect otoliths from broodstock Chinook in 2006.

WATER MANAGEMENT PLAN

In 2006, the scheduled water release occurred between 02 October and 06 October. The target release rates from Fourth Lake were as follows: 02 October-350 ft^3/s (9.90 m^3/s); 03 October-350 ft^3/s (9.90 m^3/s); 04 October-350 ft^3/s (9.90 m^3/s); 05 October-200 ft^3/s (5.66 m^3/s); and 06 October-200 ft^3/s (5.66 m^3/s). Water releases from Jump Lake were as follows: 04 October-200 ft^3/s (5.66 m^3/s), 05 October-200 ft^3/s (5.66 m^3/s), and 06 October-200 ft^3/s (5.66 m^3/s). Daily Nanaimo River discharge is presented in Table 1 and Figure 3. A summary of mean monthly Nanaimo River discharge and historical mean is presented in Figure 4.

POPULATION ESTIMATE

The number of naturally spawning fall run adult chinook in the Nanaimo River during 2006 was determined to be the AUC swim survey estimate (1943 fish) minus the net fall run broodstock removals (220 fish). Following this methodology, the total number of adult fall run chinook spawning in the Nanaimo River was estimated to be 1723 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 (1943 fish), and the First Nations fishery catch (580 fish), yielding 2523 fish. The Petersen mark-recapture calculation was also employed to estimate the fall run population. Through this methodology the estimate was 345 adults and 404 jacks (Table 3A).

An AUC estimate for fall run jack chinook (2782 fish), minus broodstock removals (66 fish), yielded 2716 natural spawners. The total return of fall run jack chinook to the Nanaimo River was determined to be the AUC estimate of 2782 fish.

Given the low water conditions that existed throughout the carcass mark-recapture program discussed below, we considered the swim survey results to be a more reliable estimate of the spawning population. We utilized the results of the final swim conducted on 12 October which yielded a peak live plus dead estimate of 672 adults. The total return of First Lake Summer run chinook is the spawning estimate (672 fish) plus adults used in broodstock (168 fish), yielding 840 fish. An estimate of 401 First Lake summer run adult chinook was derived from the Petersen mark-recapture calculation.

The Petersen mark-recapture method produced an estimate of 44 summer run jack chinook. Similar to the adults, we utilized the 12 October swim survey data to derive a jack estimate of 153 fish. This estimate plus eight jacks removed for hatchery broodstock, yield 161 jack chinook. The total return for all jack chinook to the Nanaimo River was estimated to be the total fall run jack chinook (2782 fish), plus total First Lake summer run jack chinook (161 fish), yielding 2943 fish (Table 18B).

The Upper Nanaimo River spring run chinook estimate is based on one swim which enumerated one jack at Green Creek and 45 adult chinook above Second Lake spotted during the first aerial survey. Therefore, the total return of fall and summer run adult chinook to the Nanaimo River is estimated to be 3363 fish (Table 18A).

The overall enhanced (hatchery) contribution is calculated by expanding CWT fish recovered in broodstock collection as well as those collected during the carcass mark-recapture program. Total fall run chinook enhanced contribution was determined to be 26.2%. Annual natural and enhanced (hatchery) contributions to fall run adult chinook escapements are presented in Figure 6.

DISCUSSION

CARCASS MARK-RECAPTURE

Low water conditions existed through most of the mark-recapture program which began on 17 October and ended on 13 November. Such conditions are not ideal for this study since there is not sufficient mixing of carcasses when they are returned to the river. Carcasses dropped into a river section regularly remained there and as a result, were often recaptured the following day of the program. These conditions create biases in the data collection and may explain the large difference in population estimates between the AUC and Petersen methods.

A large rise in water discharge commencing on 3 November and peaking on 6 November saw an increase from 31 m^3/s to 344 m^3/s within a three-day period. Two smaller peaks occurred on 5-6 October and 28-29 October where discharge rates of 12.81 and 11.94 m^3/s and 10.48 and 11.62 m^3/s, respectively were recorded (Table 1; Figure 3). Flooding likely caused some carcasses to be washed out of the surveying area which may be partially responsible for the poor recovery of tagged carcasses in the latter stage of the program.

Lower Nanaimo River

When comparing the mark rates between the hatchery samples and the lower river carcass mark-recapture program, a Chi-Square analysis was performed. The result indicates a significant difference between the hatchery mark rate and that of the lower river program. Hatchery samples were marked at a significantly higher rate than those recovered on the river (Chi-square = 20.58; $p<0.0001$).

Significant temporal bias was found between application and recovery samples. This suggests water discharge likely played an important role in the success of the mark-recapture program, particularly near the end.

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 swim survey estimate of 672 adult summer run chinook was well above the 1995-2005 period average of 357 fish and the highest estimate on record. The jack chinook estimate of 153 fish is nearly ten times higher than last year's estimate of 16 fish; however, no historical comparison can be made as no jack chinook carcasses were recovered in previous years (Hop Wo et al. 2006).

SWIM SURVEY

Swim surveys conducted in the lower portion of the Nanaimo River provided the primary information for generating a population estimate as well as spawning distribution of fall run chinook. The last date, 30 October, used in AUC calculations assumed that no more chinook were available to be counted on or after this date. As this is an estimate, any chinook entering the system after this date would not be included in the AUC estimate. A tagging study to obtain the survey life statistic for lower Nanaimo River chinook generated a survey life statistic 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 a lower observer efficiency, resulting in increased expansions to estimates. Similarly, the survey life statistic of 11.53 days was intended for adult chinook, and therefore assumes that adult and jack chinook both are available to be counted for the same amount of time.

Swim surveys in the upper Nanaimo River were the basis for estimating the summer run chinook. The survey on 12 October produced the results used for the final estimate.

AERIAL SURVEY

The aerial surveys provide an additional independent estimate of chinook as well as spawning distribution, especially in the upper reaches of the Nanaimo River Watershed. In the lower Nanaimo River, some misidentification is possible as chum salmon are the most abundant species in that area; however, in the upper portions of the Nanaimo River the misidentification of chinook is less likely as chum generally spawn only in lower portions of the river. 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 2006 estimate of 580 adult chinook is nearly two thirds of the 2005 estimate of 950 adult chinook, and is over five times higher than the 1975 to 2005 average of 104 fish. While we did employ a SFN member to monitor the in-river fishery, our aim was to collect biological samples from the catch. In future we intend to develop a sampling strategy that will 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. This was supported by the statistical analysis which revealed no statistical difference between the mean lengths of male or female chinook for both fall run and First Lake summer run chinook. There was however a significant difference of mean lengths between the sexes in the hatchery samples. Females (mean length 630 mm) were significantly larger than the adult males (mean length 575 mm) (Student-t: $t=-4.65$, $p<0.0001$).

There was also a significant difference (Student-t test: $t=-2.81$, $p<0.01$) between the mean lengths of jack chinook from the upper river carcass recapture program and of those sampled at the hatchery. Hatchery jacks were significantly larger (mean length 406.4 mm) than those sampled in the upper river carcass mark-recapture program (mean length 377.7 mm).

There was a 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 no statistical difference between adipose fin-clip rates of female fall run chinook carcasses collected on the spawning grounds and those collected for broodstock. Using Chi-Square analysis to test for a statistical difference between First Lake 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, First Nations food fishery and the hatchery broodstock collection, 119 (75.3%) were released into the Nanaimo River Watershed, while 39 (24.75%) were released into the Chemainus River. This is a considerable percentage of fish which strayed from their output streams but similar to the 2005 results of 29.5% Chemainus River fish recovered in the Nanaimo River.

This high proportion of straying may be partially explained by the rearing strategy established for the Chemainus River chinook. Due to chinook conservation concerns and general decline in escapement, in 2002 a decision was made to collect 150,000 eggs from the Chemainus River. The strategy involved rearing 75,000 in the Chemainus River at Sea Spring Hatchery and 75,000 at the Nanaimo River Hatchery. In the first year that target was not met but more recently it has been achieved. These smolts are released in mid-May at which time they would likely have solidly imprinted on the system in which they were reared. In 2006, a total of 185,665 eggs were raised to the eyed stage at the Chemainus River and 80,246 were transferred to the Nanaimo River Hatchery with the balance of 105,419 reared at Sea Spring Hatchery.

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 2006. Observations during swim surveys in 2006 have noted chinook upstream migration subsequent to water releases. Previous successes with water releases suggest that they are beneficial in aiding and encouraging chinook migration (Hop Wo et al. 2005).

POPULATION ESTIMATE

The 2006 Nanaimo River fall run chinook population estimate was based on the AUC swim survey calculation which produced estimates of 1943 adults and 2782 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 345 adults and 404 jacks. As mentioned, while river conditions did allow for easy access to capture, mark, and recapture carcasses, redistribution in the system was insufficient. As a result, large numbers of fish were available for recapturing which impacted the estimate and likely explains the large difference between the AUC and Petersen estimates.

The natural spawning estimate of fall run adult chinook (1723) is approximately 40% 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 and this was again chosen as the best method due to low water conditions negatively influencing the Petersen estimate. The naturally spawning estimate for First Lake adult chinook of 672 fish is above the 1995–2005 average of 357 fish. The aerial survey which occurred on 29 September and enumerated a total of 275 live chinook in the upper Nanaimo River is below the 95% confidence interval (358–452 adult chinook) generated by the Petersen calculation. Annual adult chinook escapements are presented in Figure 8.

The fall run natural spawning estimate of 2782 jacks is triple the 1995–2005 average of 856 fish, however the Petersen estimate of 398 (95% C.I. 294 - 502) is about half. The First Lake summer run naturally spawning jack chinook swim survey estimate of 153 fish cannot be compared to a historical estimate as the only other estimate provided was in 1995 where 200 jack chinook were estimated to have spawned in the upper Nanaimo River.

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Table 1. Nanaimo River daily discharge[1] (m^3/s), 2006.

	Month											
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	160.61	117.38	32.4	45.1	46.2	26.5	7.05	4.76	4.52	3.76	7.4	24.06
2	199.45	138.93	35.7	50.4	37	40	6.59	4.8	4.53	3.69	6.23	21.98
3	140.49	117.63	36.3	47.8	30.8	43.1	6.15	5.18	4.51	3.91	30.67	20.46
4	102.65	211.07	33.3	48.2	27.8	37.4	5.91	5.28	4.68	6.54	98.57	20.01
5	236.3	189.65	30.1	46.3	30.4	31	5.82	5.23	4.22	12.81	134.78	21.34
6	313.12	118.49	33.7	42.8	35.7	25.6	5.76	5.03	4.1	11.94	344.39	22.17
7	203.12	79.5	62.1	36.9	36.4	23.3	5.63	4.78	3.97	6.84	329.43	22.56
8	131.8	59.13	64.8	35.6	35.9	22.7	5.51	4.72	4.09	6.02	146.12	24.59
9	207.55	48.02	66.5	40.5	31.7	22.7	5.57	4.82	4.67	5.61	77.74	33.4
10	196.61	40.14	53.5	49.8	26.8	21.2	5.58	4.65	4.88	5.3	67.08	43.35
11	147.59	34.7	41.1	51.4	25	20.7	6.14	4.95	4.96	5.09	71.36	168.9
12	119.66	30.28	32.9	47.6	26.1	20.3	6.8	4.76	5.15	4.95	76.13	301.8
13	190.42	27.74	27.3	43.4	24.9	19.6	6.5	4.61	5.39	4.66	108.07	294.3
14	195.85	26.34	23.8	52.6	22.7	18.9	6.4	4.51	5.43	4.4	88.02	247.4
15	127.93	24.72	22.4	55.8	22.6	17	6.7	4.43	4.92	4.3	301.12	182.7
16	94.5	22.81	23.4	54	36.1	15.6	6.48	4.49	4.56	4.25	441.95	122.7
17	188.83	20.73	24.6	47.9	56.9	16.3	6.18	4.63	4.45	4.3	277.82	86.31
18	170.25	18.7	24.3	40.9	59	16	5.9	4.9	4.6	4.61	233.93	64.77
19	116.82	17.34	22.7	35.9	53.4	14.3	5.57	5.15	5.52	4.54	205.73	65.73
20	85.9	16.3	21	34.4	48.5	12.9	5.46	5.3	5.93	4.33	215.21	94.23
21	67.87	15.68	19.5	51	41.5	11.7	5.41	5.05	5.96	4.15	174.48	225
22	55.85	14.64	24.2	53.5	39.3	10.2	5.5	5.13	5.67	3.97	142.77	171.3
23	48.91	14.08	63	47.6	39.9	9.3	5.54	5.2	5.15	3.81	104.68	110.8
24	44.95	13.54	117.5	42.2	41.4	8.7	5.36	5.3	4.71	3.76	77.85	87.54
25	38.39	12.73	115.7	42.8	42.8	8.6	5.1	5.36	4.25	3.71	60.01	109.5
26	52.12	12.95	84.7	48.2	40.9	8.8	4.98	5.18	4	3.78	49.26	104.3
27	59.18	21	62.5	45.3	36.2	8.9	4.91	4.76	3.89	7.86	39.94	81.29
28	62.72	29.63	47	43.3	32.9	8.9	4.8	4.7	3.84	10.48	33.46	60.88
29	59.49		36.8	54.4	28.8	8.2	4.88	4.69	3.82	11.62	29.03	47.13
30	72.45		33.7	54.5	25.1	7.5	4.91	4.76	3.78	11	26.79	38.46
31	78.49		35.6		23.7		4.89	4.71		9.34		33.25
Total	3969.9	1493.8	1352.1	1390.1	1106.4	555.9	178	151.8	140.1	185.3	4000	2952.2
Mean	128.06	53.35	43.62	46.34	35.69	18.53	5.74	4.9	4.67	5.98	133.33	95.23
Max	313.12	211.07	117.5	55.8	59	43.1	7.05	5.36	5.96	12.81	441.95	301.8
Min	38.39	12.73	19.5	34.4	22.6	7.5	4.8	4.43	3.78	3.69	6.23	20.01

[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 2A. Daily summary of fall run chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2006.

	Carcasses Examined				Tags Applied				Recaptured Carcasses			
Date	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown
19-Oct	13	8	5	0	13	8	5	0	0	0	0	0
20-Oct	0	1	1	0	0	1	1	0	0	0	0	0
23-Oct	20	14	7	0	20	14	7	0	5	4	3	0
24-Oct	8	5	14	0	8	5	14	0	3	0	1	0
25-Oct	0	0	4	0	0	0	4	0	1	0	1	0
26-Oct	17	11	25	0	17	11	25	0	12	9	6	0
27-Oct	9	0	18	0	9	0	18	0	2	3	3	0
30-Oct	12	8	11	0	12	8	11	0	14	10	13	0
31-Oct	5	2	7	0	5	2	7	0	0	0	3	0
01-Nov	0	0	2	0	0	0	0	0	0	0	0	0
02-Nov	16	8	19	0	16	8	19	0	7	5	5	0
03-Nov	5	2	9	0	5	2	9	0	2	0	1	0
10-Nov	0	0	1	0	0	0	1	0	1	0	0	0
13-Nov	0	0	1	0	0	0	1	0	0	0	1	0
Total	105	59	124	0	105	59	122	0	47	31	37	0

Table 2B. Daily summary of summer run chinook sampled during the carcass mark-recapture program, upper Nanaimo River, 2006.

	Carcasses Examined				Tags Applied				Recaptured Carcasses			
Date	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown
17-Oct	26	25	2	0	26	25	2	0	0	0	0	0
18-Oct	46	12	9	0	46	12	9	0	0	0	0	0
19-Oct	4	8	3	0	4	8	3	0	0	0	0	0
20-Oct	13	23	2	0	13	23	2	0	39	25	5	1
23-Oct	25	21	5	2	25	21	5	2	20	22	4	0
25-Oct	2	4	1	1	2	4	1	0	5	10	2	1
30-Oct	4	5	0	0	4	5	0	0	0	1	0	0
03-Nov	4	1	0	0	4	1	0	0	1	1	0	0
Total	124	99	22	3	124	99	22	2	65	59	11	2

Table 3A. Petersen fall run chinook escapement estimates by sex, lower Nanaimo River, 2006.

Sex	Population Estimate	95% Confidence Limits Lower	Upper
Adult Male [1]	234	186	283
Female	112	86	139
Total Adult	**345**	**290**	**399**
Jack	404	299	511
Total Population	715	615	815

[1]Jacks not included.

Table 3B. Petersen First Lake summer run chinook escapement estimates by sex, upper Nanaimo River, 2006.

Sex	Population Estimate	95% Confidence Limits Lower	Upper
Adult Male [1]	237	198	276
Female	167	140	193
Total Adult	**401**	**355**	**448**
Jack	44	28	61
Total Population	445	395	495

[1]Jacks not included.

Table 4. Swim survey counts for adult chinook with observer efficiency and system estimates, conducted on the Nanaimo River, 2006.

		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
17-Jul	85%	25	0	131	0	29	0	154	0	29	154	**A**
27-Jul	85%	220	0	30	0	259	0	35	0	259	35	**B**
24-Aug	85%	230	0	40	0	271	0	47	0	271	47	**B**
24-Aug	85%	0	0	0	0	0	0	0	0	0	0	**C**
24-Aug	85%	20	0	30	0	24	0	35	0	24	35	**E**
07-Sep	85%	299	0	102	0	352	0	120	0	352	120	**E**
11-Sep	85%	231	0	375	0	272	0	441	0	272	441	**E**
18-Sep	85%	302	0	533	0	355	0	627	0	355	627	**E**
25-Sep	85%	580	0	310	0	682	0	365	0	682	365	**E**
02-Oct	85%	356	0	675	0	419	0	794	0	419	794	**E**
10-Oct	85%	341	0	599	0	401	0	705	0	401	705	**E**
12-Oct	85%	571	0	102	28	672	0	120	33	672	153	**D**
16-Oct	85%	301	0	434	0	354	0	511	0	354	511	**F**
23-Oct	85%	169	0	282	0	199	0	332	0	199	332	**F**
30-Oct	85%	90	0	118	0	106	0	139	0	106	139	**F**

Comments

A Swim completed in the upper sections of the river, between Green Creek and South Fork junction.

B Upper river; Southfork junction

C Upper river; Green creek junction

D Includes portions of the upper river; First Lake to Wolf Creek.

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

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

Table 5. Aerial Surveys conducted on the Nanaimo River, 2006.

	29-Sep-06				17-Oct-06				1-Nov-06			
	Chinook		Chum		Chinook		Chum		Chinook		Chum	
River Section	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead
Estuary-Cedar Bridge	150		80				2500	200			6000	1500
Cedar Bridge-Hwy Bridge	74		2		150	7	5300	600	8	31	15300	8350
Hwy Bridge-Borehole	60								27	9		
South Fork-First Lake	30								37	24		
First Lake	150											
Between First and Second Lake	50											
Second Lake-Green Creek	45											
Green Creek to Teepee Bridge					21	18						
Total	559		82		171	25	7800	800	72	64	21300	9850

Table 6. Summary by day and location of chinook collected for Nanaimo River Hatchery broodstock, 200

Fall Run Chinook

Date (dd/mmm)	Location[1]	Chinook Male	Female	Jack
28-Sep	San Salvador	13	28	14
06-Oct	Hwy. Bridge Pool	2	2	5
06-Oct	Pipe Pool	7	5	3
10-Oct	Bridge Pool	63	17	11
11-Oct	Bridge Pool	0	1	0
11-Oct	Pipe Pool	0	7	0
12-Oct	Bridge Pool	0	1	0
12-Oct	Hermanns Hole	0	0	10
16-Oct	Hermanns Hole	7	3	0
17-Oct	Bridge Pool	8	8	0
17-Oct	Hermanns Hole	0	0	0
17-Oct	Pumphouse Pool	0	0	0
18-Oct	Haslam Junction	0	9	0
18-Oct	Pipe Pool	0	12	0
19-Oct	Bridge Pool	0	3	0
19-Oct	Hermanns Hole	0	0	0
19-Oct	Pumphouse Pool	0	6	0
25-Oct	Pipe Pool	0	5	0
Total		**100**	**107**	**43**

Summer Run Chinook

Date (dd/mmm)	Location[2]	Chinook Male	Female	Jack
02-Oct	First Lake	25	71	8
03-Oct	First Lake	29	9	0
04-Oct	First Lake	19	15	0
Total		**73**	**95**	**8**

[1] See Figure 2.
[2] See Figure 1.

Table 7A. Length-frequency of fall run chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2006.

Length (cm)	Males	Females	Jacks
32	0	0	1
33	0	0	0
34	0	0	1
35	0	0	5
36	0	0	4
37	0	1	3
38	0	0	7
39	0	0	5
40	0	0	14
41	0	0	11
42	0	0	12
43	0	0	4
44	0	0	20
45	0	0	14
46	0	0	7
47	0	0	10
48	11	0	0
49	4	0	0
50	2	1	0
51	3	0	0
52	2	1	0
53	2	0	0
54	3	0	0
55	2	3	0
56	1	2	0
57	1	1	0
58	7	5	0
59	5	2	0
60	5	5	0
61	13	4	0
62	4	4	0
63	6	3	0
64	8	3	0
65	1	4	0
66	1	1	0
67	3	4	0
68	7	2	0
69	5	3	0
70	4	3	0
71	1	0	0
72	1	2	0
73	1	0	0
74	1	6	0
75	2	0	0

Table 7A. (continued)

Length (cm)	Males	Females	Jacks
76	1	0	0
77	0	0	0
78	1	1	0
79	1	0	0
80	0	0	0
81	0	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	0	0	0
86	1	0	0
Total	110	61	118
Mean Length	60.9	63.4	41.9
Std. Deviation	8.1	7.1	3.5
Adipose Clips	15	9	47
Mark Rate	13.64%	14.75%	39.80%

Table 7B. Length-frequency of summer run chinook sampled during the carcass mark-recapture program, upper Nanaimo River, 2006.

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

Table 7B. (continued)

Length (cm)	Males	Females	Jacks
73	1	0	0
74	1	1	0
75	2	0	0
76	0	0	0
77	0	1	0
78	0	0	0
79	1	0	0
80	0	0	0
81	1	0	0
82	1	0	0
83	1	0	0
84	0	0	0
85	0	0	0
86	0	1	0
Total	127	98	19
Mean Length	60.5	61.9	37.7
Std. Deviation	7.1	5.7	3.0

Table 8A. Summary of age data from fall run chinook sampled during the carcass mark-recovery program, lower Nanaimo River, 2006.

	Brood		Males		Females		Total	
European Age [1]	Year	Total Age	#	%	#	%	#	%
0.1	2004	2	44	62.0%	2	12.5%	46	52.9%
0.2	2003	3	22	31.0%	8	50.0%	30	34.5%
0.3	2002	4	4	5.6%	4	25.0%	8	9.2%
0.4	2001	5	0	0.0%	1	6.3%	1	1.1%
1.2	2002	4	1	1.4%	1	6.3%	2	2.3%
Total			71	100%	16	100%	87	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).

Total number of unreadable scales: 13

Table 8B. Summary of age data from First Lake summer run chinook sampled during the carcass mark-recapture program, upper Nanaimo River, 2006.

	Brood	Total	Males		Females		Total	
European Age [1]	Year	Age	#	%	#	%	#	%
0.1	2004	2	20	41.7%	1	2.6%	21	24.4%
0.2	2003	3	28	58.3%	36	94.7%	64	74.4%
0.3	2002	4	0	0.0%	1	2.6%	1	1.2%
Total			48	100%	38	100%	86	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).

Total number of unreadable scales: 3

Table 9A. Percentage of the tag application sample recovered on the spawning grounds, by application period and sex, lower Nanaimo River, 2006.

Applicatio n Period	Days of Application	Tags Applied				Tagged Recoveries				Percent Recovered			
		Male	Female	Jack	Total	Male	Female	Jack	Total	Male	Femal e	Jack	Total
19-Oct - 23-Oct	3	33	23	13	69	5	4	3	12	15.15	17.39	23.07	17.39
24-Oct - 26-Oct	3	30	16	37	83	16	9	8	35	53.33	56.25	21.62	42.17
27-Oct - 31-Oct	3	27	10	35	72	16	13	18	47	59.26	130	51.43	65.28
1-Nov - 13-Nov	5	23	10	29	62	8	5	8	21	34.78	50	27.58	33.87
Total	14	113	59	114	286	45	31	37	115	39.82	52.54	32.46	40.21

Table 9B. Percentage of the tag application sample recovered on the spawning grounds, by application period and sex, upper Nanaimo River, 2006.

Application Period	Days of Applicatio n	Tags Applied				Tagged Recoveries				Percent Recovered			
		Male	Femal e	Jack	Total	Male	Femal e	Jack	Total	Male	Femal e	Jack	Total
17-Oct - 20-Oct	4	92	68	13	173	35	23	3	61	38.04	33.82	23.08	35.26
23-Oct - 03-Nov	4	35	31	5	71	23	29	6	58	65.71	93.55	120	81.69

Total	8	127	99	18	244	58	52	9	119	45.67	52.52	50	48.77

Table 10. Length-frequency of fall run chinook sampled during broodstock collection at the Nanaimo River Hatchery, 2006.

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

Table 10 (continued)

Length (cm)	Males	Females	Jacks
73	0	3	0
74	0	2	0
75	0	1	0
76	1	0	0
77	0	0	0
78	0	0	0
79	0	0	0
80	0	0	0
81	0	0	0
82	0	1	0
Total	27	84	76
Mean Length (cm)	59.0	62.5	41.2
Std. Deviation	6.0	6.1	4.5
Adipose Clips	8	25	54
Mark Rate	29.6%	29.8%	71.1%

Table 11A. Summary of age data from fall run chinook broodstock collection, lower Nanaimo River, 2006.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2004	2	74	74.7%	0	0.0%	74	44.3%
0.2	2003	3	22	22.2%	52	76.5%	74	44.3%
0.3	2002	4	3	3.0%	13	19.1%	16	9.6%
0.4	2001	5	0	0.0%	3	4.4%	3	1.8%
1.1	2003	3	0	0.0%	0	0.0%	0.0%	0.0%
Total			99	100%	68	100%	167	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).

Total number of unreadable scales: 18

Table 11B. Summary of age data from First Lake summer run chinook broodstock collection, upper Nanaimo River, 2006.

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2004	2	46	64.8%	0	0.0%	46	32.6%
0.2	2003	3	22	31.0%	54	77.1%	76	53.9%
0.3	2002	4	3	4.2%	13	18.6%	16	11.3%
0.4	2001	5	0	0.0%	3	4.3%	3	2.13%
Total			71	100%	70	100%	141	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, 2006.

Recovery Data				Release Data				
		POH Length		Brood	CWT		Release Date	
Date	Location[1]	(mm)	Sex	Year	Code	Location	Start	End
19-Oct-06	23	689	F	2002	185129	Chemainus R.	15-May-03	16-May-03
19-Oct-06	20	553	F	2003	185530	Chemainus R.	07-May-04	17-May-04
19-Oct-06	20	461	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
20-Oct-06	13	405	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
23-Oct-06	21	682	M	2003	185530	Chemainus R.	07-May-04	17-May-04
23-Oct-06	21	471	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
23-Oct-06	21	624	M	2003	185531	Chemainus R.	17-May-04	18-May-04
23-Oct-06	20	473	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
23-Oct-06	19	468	J	2004	185717	Nanaimo R.	19-May-05	15-Jun-05
23-Oct-06	19	598	F	2003	185531	Chemainus R.	17-May-04	18-May-04
23-Oct-06	19	445	J	2004	185717	Nanaimo R.	19-May-05	15-Jun-05
23-Oct-06	19	583	M	2003	185531	Chemainus R.	17-May-04	18-May-04
24-Oct-06	19	459	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
24-Oct-06	17	614	M	2003	185531	Chemainus R.	17-May-04	18-May-04
24-Oct-06	17	476	M	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
24-Oct-06	14	418	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
24-Oct-06	13	487	J	2004	185714	Nanaimo R.	16-May-05	15-Jun-05
25-Oct-06	11	443	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
25-Oct-06	11	467	J		No Pin			
25-Oct-06	11	469	M	2004	185717	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	23	598	M	2003	185531	Chemainus R.	17-May-04	18-May-04
26-Oct-06	23	655	F	2002	185528	Nanaimo R.	31-May-03	31-May-03
26-Oct-06	23	359	J		No Pin			
26-Oct-06	21	442	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	21	453	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	21	632	M	2003	185531	Chemainus R.	17-May-04	18-May-04
26-Oct-06	20	440	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	447	J		No Pin			
26-Oct-06	20	406	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	446	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	445	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	340	J		No Pin			
26-Oct-06	20	446	J	2004	185714	Nanaimo R.	16-May-05	15-Jun-05

Table 12. (Continued)

Recovery Data				Release Data				
		POH Length		Brood	CWT		Release Date	
Date	Location[1]	(mm)	Sex	Year	Code	Location	Start	End
26-Oct-06	20	440	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	442	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	476	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	464	J	2004	185715	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	20	436	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	19	609	M	2003	185530	Chemainus R.	07-May-04	17-May-04
26-Oct-06	19	632	F	2003	185531	Chemainus R.	17-May-04	18-May-04
26-Oct-06	19	579	F	2003	185531	Chemainus R.	17-May-04	18-May-04
26-Oct-06	19	417	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
26-Oct-06	19	448	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
27-Oct-06	18	582	M	2003	185531	Chemainus R.	17-May-04	18-May-04
27-Oct-06	18	404	J	2004	185713	Nanaimo R.	19-May-05	15-Jun-05
27-Oct-06	14	435	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
27-Oct-06	14	452	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
27-Oct-06	14	436	J	2004	185717	Nanaimo R.	19-May-05	15-Jun-05
27-Oct-06	14	450	J	2004	185714	Nanaimo R.	16-May-05	15-Jun-05
27-Oct-06	14	487	J	2004	185715	Nanaimo R.	19-May-05	15-Jun-05
27-Oct-06	13	380	J	2004	185714	Nanaimo R.	16-May-05	15-Jun-05
27-Oct-06	13	353	J		No Pin			
30-Oct-06	21	548	F		No Pin			
30-Oct-06	20	485	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
30-Oct-06	20	653	F	2003	185531	Chemainus R.	17-May-04	18-May-04
30-Oct-06	19	444	J	2004	185717	Nanaimo R.	19-May-05	15-Jun-05
30-Oct-06	19	432	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
31-Oct-06	14	363	J		No Pin			
01-Nov-06	11	322	J		No Pin			
01-Nov-06	10	423	J	2004	185717	Nanaimo R.	19-May-05	15-Jun-05
02-Nov-06	20	404	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
02-Nov-06	20	639	F		No Pin			
02-Nov-06	20	442	J	2004	185802	Nanaimo R.	19-May-05	15-Jun-05
02-Nov-06	19	444	J	2004	185715	Nanaimo R.	19-May-05	15-Jun-05
02-Nov-06	19	467	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
02-Nov-06	19	353	J		No Pin			
02-Nov-06	19	476	J	2004	185716	Nanaimo R.	19-May-05	15-Jun-05
03-Nov-06	19	408	J	2004	185715	Nanaimo R.	19-May-05	15-Jun-05

Table 12. (Continued)

Recovery Data				Release Data				
		POH Length		Brood	CWT		Release Date	
Date	Location[1]	(mm)	Sex	Year	Code	Location	Start	End
03-Nov-06	19	472	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05
03-Nov-06	19	395	J		No Pin			
03-Nov-06	19	672	M		No Pin			
03-Nov-06	19	456	J	2004	185715	Nanaimo R.	19-May-05	15-Jun-05
10-Nov-06	6	412	J	2004	185803	Nanaimo R.	19-May-05	15-Jun-05

Table 13. Snuneymuxw First Nations Food Fish Summary, 2006.

Date	Number of Fish Sampled: Chinook Male	Chinook Female	Chinook Jack	Coho Male	Coho Female	Coho Jack	Total No. of Fishers Obs.	No. of Fish Obs. Not Biosampled: Chinook	Coho	Chum
23-Sep-06			1				1			
24-Sep-06	2	5	2	1	1		13	1		
25-Sep-06	4			6	1	1	2	1	1	8
27-Sep-06	2						4			2
30-Sep-06	1	1	1	1			3			1
2-Oct-06	1	1			2		2			2
5-Oct-06		1					7			11
7-Oct-06		1		1	1		8		1	8
9-Oct-06	1		5	2	2	1	15		2	124
12-Oct-06	1	2		7	7	1	6			60
13-Oct-06			4	1			2		7	
14-Oct-06		1	1	1			2			
15-Oct-06				1	1		6		1	50
16-Oct-06				2	1		1			28
17-Oct-06					3		1			50
21-Oct-06				3	1		4			300
22-Oct-06				1			3			10
23-Oct-06					2		2			12
24-Oct-06				1			7		1	27
Total	12	12	14	28	22	3	89	2	13	693

Table 14. Coded-wire tag data from chinook sampled on the Snuneymuxw First Nations food fishery on the Nanaimo River in 2006.

Recovery Data			Release Data				
	POH			Brood		Release Date	
Date	Length (mm)	Sex	CWT Code	Year	Location	Start	End
23-Sep	421	J	185713	2004	Nanaimo R.	19-May-05	15-Jun-05
24-Sep	553	M	185531	2003	Chemainus R.	17-May-04	18-May-04
24-Sep	401	J	185716	2004	Nanaimo R.	19-May-05	15-Jun-05
25-Sep	495	J	185717	2004	Nanaimo R.	19-May-05	15-Jun-05
25-Sep	485	J	185716	2004	Nanaimo R.	19-May-05	15-Jun-05
27-Sep			185715	2004	Nanaimo R.	19-May-05	15-Jun-05
30-Sep	446	J	185802	2004	Nanaimo R.	19-May-05	15-Jun-05
09-Oct	473	J	185717	2004	Nanaimo R.	19-May-05	15-Jun-05
09-Oct	455	J	185802	2004	Nanaimo R.	19-May-05	15-Jun-05
09-Oct	476	J	185803	2004	Nanaimo R.	19-May-05	15-Jun-05
09-Oct	416	J	185803	2004	Nanaimo R.	19-May-05	15-Jun-05
09-Oct	428	J	185717	2004	Nanaimo R.	19-May-05	15-Jun-05
13-Oct	444	J	185716	2004	Nanaimo R.	19-May-05	15-Jun-05
14-Oct	442	J	185714	2004	Nanaimo R.	16-May-05	15-Jun-05

Table 15. Coded-wire tag data from chinook sampled at Nanaimo River Hatchery, 2006.

Recovery Data			Release Data				
Date	POH Length (mm)	Sex	Brood Year	Tag Code	Location	Release Date Start	Release Date End
01-Sep	475	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
05-Oct	635	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	615	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	612	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	632	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	619	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	663	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	735	F	2001	184717	Nanaimo R	9-May-02	9-May-02
10-Oct	660	F	2002	185527	Nanaimo R	31-Jul-03	31-Jul-03
10-Oct	605	F	2003	185531	Chemainus R	17-May-04	18-May-04
10-Oct	616	F	2003	185530	Chemainus R	7-May-04	17-May-04
12-Oct	555	M	2003	185531	Chemainus R	17-May-04	18-May-04
12-Oct	440	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
14-Oct	400	M	2004	185717	Nanaimo R	19-May-05	15-Jun-05
14-Oct	361	J	2004	185717	Nanaimo R	19-May-05	15-Jun-05
14-Oct	430	M	2004	185716	Nanaimo R	19-May-05	15-Jun-05
15-Oct	506	F	2003	185531	Chemainus R	17-May-04	18-May-04
15-Oct	584	F	2003	185530	Chemainus R	7-May-04	17-May-04
15-Oct	470	F		No-pin			
15-Oct	615	F	2003	185531	Chemainus R	17-May-04	18-May-04
15-Oct	404	M	2004	185714	Nanaimo R	16-May-05	15-Jun-05
15-Oct	380	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
16-Oct	425	M	2004	185714	Nanaimo R	16-May-05	15-Jun-05
17-Oct	660	F	2001	183206	Nanaimo R	14-May-02	14-May-02
17-Oct	575	F	2002	185132	Chemainus R	15-May-03	16-May-03
17-Oct	617	F	2002	185131	Chemainus R	15-May-03	16-May-03
18-Oct	640	M	2003	185531	Chemainus R	17-May-04	18-May-04
18-Oct	346	J	2004	185717	Nanaimo R	19-May-05	15-Jun-05
18-Oct	630	F	2003	185530	Chemainus R	7-May-04	17-May-04
20-Oct	410	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
20-Oct	425	M	2004	185717	Nanaimo R	19-May-05	15-Jun-05
20-Oct	415	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
20-Oct	406	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
20-Oct	410	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
20-Oct	420	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
20-Oct	700	M	2002	185527	Nanaimo R	31-Jul-03	31-Jul-03
20-Oct	460	M		No-pin			
20-Oct	705	F	2001	184715	Nanaimo R	16-May-02	16-May-02
20-Oct	610	F	2003	185531	Chemainus R	17-May-04	18-May-04
20-Oct	690	F	2002	185130	Chemainus R	15-May-03	16-May-03
21-Oct	440	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
21-Oct	410	M	2004	185716	Nanaimo R	19-May-05	15-Jun-05

Table 15. (Continued)

Recovery Data			Release Data				
	POH Length		Brood	Tag		Release Date	
Date	(mm)	Sex	Year	Code	Location	Start	End
21-Oct	400	J	2004	185717	Nanaimo R	19-May-05	15-Jun-05
21-Oct	38	J	2004	185714	Nanaimo R	16-May-05	15-Jun-05
21-Oct	310	J		No-pin			
21-Oct	400	J	2004	185715	Nanaimo R	19-May-05	15-Jun-05
21-Oct	380	J		No-pin			
21-Oct	370	J	2004	185802	Nanaimo R	19-May-05	15-Jun-05
21-Oct	385	J	2004	185717	Nanaimo R	19-May-05	15-Jun-05
21-Oct	400	J	2004	185717	Nanaimo R	19-May-05	15-Jun-05
21-Oct	370	J	2004	185714	Nanaimo R	16-May-05	15-Jun-05
21-Oct	440	M	2004	185716	Nanaimo R	19-May-05	15-Jun-05
21-Oct	430	M	2004	185715	Nanaimo R	19-May-05	15-Jun-05
21-Oct	410	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
21-Oct	490	M	2004	185717	Nanaimo R	19-May-05	15-Jun-05
22-Oct	591	M	2003	185531	Chemainus R	17-May-04	18-May-04
22-Oct	494	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
22-Oct	645	M	2002	185132	Chemainus R	15-May-03	16-May-03
22-Oct	585	M	2003	185531	Chemainus R	17-May-04	18-May-04
22-Oct	462	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
22-Oct	457	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
22-Oct	472	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
22-Oct	474	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
22-Oct	458	M	2004	185714	Nanaimo R	16-May-05	15-Jun-05
22-Oct	421	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
22-Oct	408	J	2004	185717	Nanaimo R	19-May-05	15-Jun-05
23-Oct	455	M	2004	185716	Nanaimo R	19-May-05	15-Jun-05
23-Oct	370	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
23-Oct	628	F	2003	185531	Chemainus R	17-May-04	18-May-04
23-Oct	563	F	2003	185530	Chemainus R	7-May-04	17-May-04
24-Oct	474	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
24-Oct	436	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
24-Oct	451	M		No-pin			
24-Oct	452	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
24-Oct	470	M	2004	185715	Nanaimo R	19-May-05	15-Jun-05
24-Oct	433	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05
25-Oct	435	M	2004	185715	Nanaimo R	19-May-05	15-Jun-05
25-Oct	385	J	2004	185802	Nanaimo R	19-May-05	15-Jun-05
26-Oct	676	F	2002	185129	Chemainus R	15-May-03	16-May-03
26-Oct	743	F	2002	185527	Nanaimo R	31-Jul-03	31-Jul-03
28-Oct	420	M	2004	185715	Nanaimo R	19-May-05	15-Jun-05
28-Oct	450	M	2004	185713	Nanaimo R	19-May-05	15-Jun-05
28-Oct	410	M	2004	185717	Nanaimo R	19-May-05	15-Jun-05
29-Oct	470	M	2004	185717	Nanaimo R	19-May-05	15-Jun-05
30-Oct	366	J	2004	185714	Nanaimo R	16-May-05	15-Jun-05

Table 15. (Continued)

Recovery Data			Release Data				
	POH Length		Brood	Tag		Release Date	
Date	(mm)	Sex	Year	Code	Location	Start	End
30-Oct	488	M	2004	185803	Nanaimo R	19-May-05	15-Jun-05
31-Oct	476	M	2004	185802	Nanaimo R	19-May-05	15-Jun-05

Table 16. Nanaimo River Hatchery chinook release data for brood years 1997 - 2005.

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	07/05/1998	07/05/1998	First Lake	Summer
183221	1997	25,173	99,098	25.4	6	15/05/1998	15/05/1998	First Lake	Summer
183223	1997	28,252	43,881	64.38	6.01	26/05/1998	26/05/1998	Nanaimo R.	Fall
182408	1997	10,050	15,610	64.38	6.01	26/05/1998	26/05/1998	Nanaimo R.	Fall
183222	1997	24,824	24,824	100	15.5	23/07/1998	23/07/1998	Jack Point	Fall
-	1998	0	442,830	0	5.1	12/05/1999	13/05/1999	Nanaimo R.	Fall
-	1998	0	165,595	0	5.61	28/05/1999	28/05/1999	First Lake	Summer
-	1998	0	50,411	0	11	02/06/1999	08/07/1999	Jack Point	Fall
184330	1999	25,185	257,394	9.78	4.03	17/05/2000	17/05/2000	First Lake	Summer
184332	1999	25,071	25,071	100	5.1	18/05/2000	18/05/2000	Nanaimo R.	Fall
184331	1999	25,185	25,185	100	5.1	18/05/2000	18/05/2000	Nanaimo R.	Fall
184333	1999	25,165	25,165	100	5.1	18/05/2000	18/05/2000	Nanaimo R.	Fall
184334	1999	25,231	25,231	100	5.1	18/05/2000	18/05/2000	Nanaimo R.	Fall
-	1999	0	99,238	0	4.8	18/05/2000	18/05/2000	Nanaimo R.	Fall
184335	1999	25,300	126,422	20.01	5	05/05/2000	23/05/2000	Nanaimo R.	Fall
184336	1999	25,115	125,497	20.01	5	05/05/2000	23/05/2000	Nanaimo R.	Fall
184329	1999	25,175	57,625	43.69	10.34	23/06/2000	23/06/2000	Jack Point	Fall
184363	2000	24,739	207,955	11.9	6.56	23/05/2001	24/05/2001	First Lake	Summer
184552	2000	50,060	105,512	47.44	4.9	28/04/2001	29/05/2001	Nanaimo R.	Fall
184554	2000	50,259	105,931	47.45	4.9	28/04/2001	29/05/2001	Nanaimo R.	Fall
184553	2000	50,254	105,920	47.45	4.9	28/04/2001	29/05/2001	Nanaimo R.	Fall
184362	2000	25,091	51,070	49.13	8.67	06/06/2001	06/06/2001	Jack Point	Fall
184717	2001	25,119	102,917	24.41	4.68	09/05/2002	09/05/2002	Nanaimo R.	Fall
184718	2001	25,355	103,883	24.41	4.68	09/05/2002	09/05/2002	Nanaimo R.	Fall
183205	2001	25,182	25,182	100	5.61	14/05/2002	14/05/2002	Nanaimo R.	Fall
183206	2001	25,237	25,237	100	5.61	14/05/2002	14/05/2002	Nanaimo R.	Fall
184337	2001	25,102	186,187	13.48	5.7	16/05/2002	16/05/2002	First Lake	Summer
184715	2001	25,307	25,307	100	3.78	16/05/2002	16/05/2002	Nanaimo R.	Fall
184716	2001	25,131	25,131	100	3.78	16/05/2002	16/05/2002	Nanaimo R.	Fall
184628	2001	25,119	51,508	48.77	6.62	17/05/2002	17/05/2002	Jack Point	Fall
185527	2002	39,650	39,650	100	20	31/07/2003	31/07/2003	Nanaimo R.	Fall
185528	2002	40,226	40,226	100	10	31/05/2003	31/05/2003	Nanaimo R.	Fall
-	2002	0	173,081	0	7.17	06/05/2003	19/05/2003	First Lake	Summer
-	2002	0	324,204	0	6	08/05/2003	21/05/2003	Nanaimo R.	Fall
-	2003	0	187,214	0	6.93	18/05/2004	18/05/2004	First Lake	Summer
-	2003	0	120,199	0	4.86	19/05/2004	19/05/2004	Nanaimo R.	Fall
185713	2004	29,538	38,922	75.89	5.0	19/05/2005	15/06/2005	Nanaimo R.	Fall
185714	2004	29,559	39,146	75.51	5.0	16/05/2005	15/06/2005	Nanaimo R.	Fall
185715	2004	29,392	38,729	75.89	5.0	19/05/2005	15/06/2005	Nanaimo R.	Fall
185716	2004	29,293	38,792	75.51	5.0	19/05/2005	15/06/2005	Nanaimo R.	Fall
185717	2004	29,124	38,763	75.13	5.0	19/05/2005	15/06/2005	Nanaimo R.	Fall
185802	2004	27,774	36,782	75.51	5.0	19/05/2005	15/06/2005	Nanaimo R.	Fall
185803	2004	24,568	32,535	75.51	5.0	19/05/2005	15/06/2005	Nanaimo R.	Fall
-	2004	0	154,922	0	8.0	18/05/2005	19/05/2005	First Lake	Summer

Table 16 (continued). Nanaimo River Hatchery chinook release data for brood years 1997 - 2005.

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

Table 17. Chemainus River and Cowichan River chinook release data for brood years 2002 - 2005.

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
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

Table 18A. Total adult chinook returns to the Nanaimo River, 1975-2006.

	Natural Spawners		Hatchery Broodstock		First Nations Food Fish	Total
Year	Fall	Summer	Fall	Summer[1]	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]

[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, 1995-2006.

	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

[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.

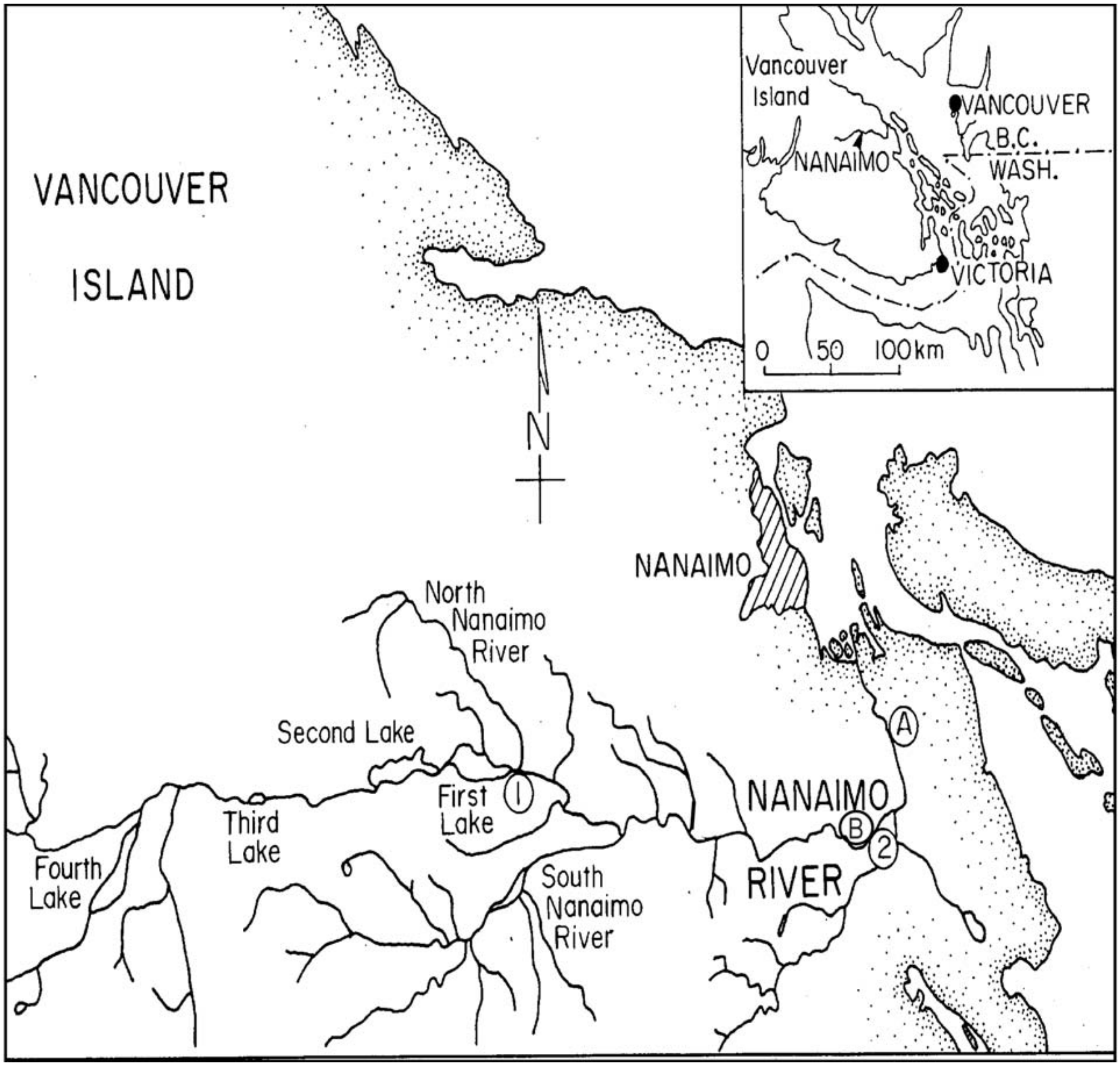
[5] Mark recapture estimate plus fall broodstock removal, Native food fish catch and spring run estimate.

[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.

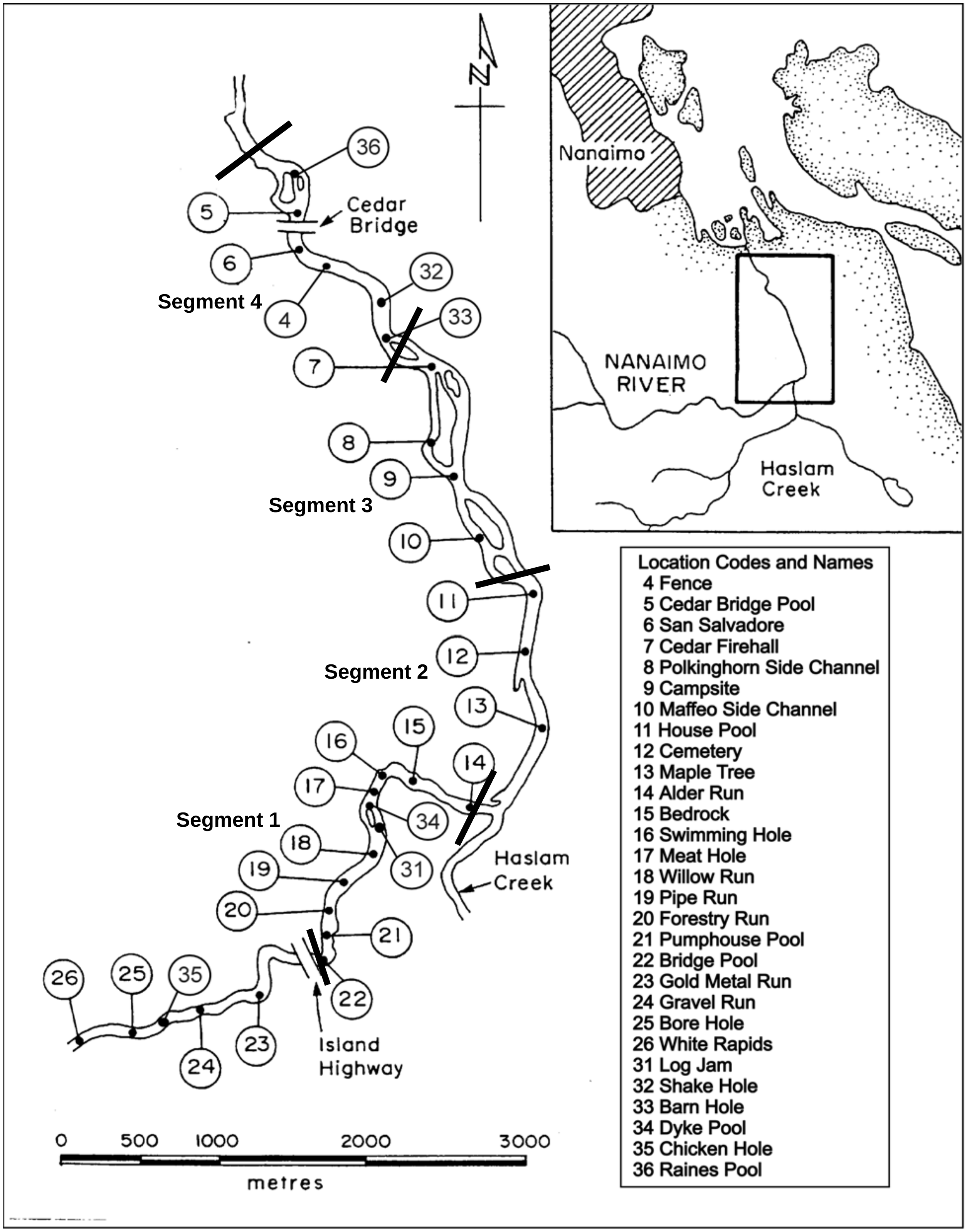


Figure 2. Swim survey and mark-recapture sites on the lower Nanaimo River.

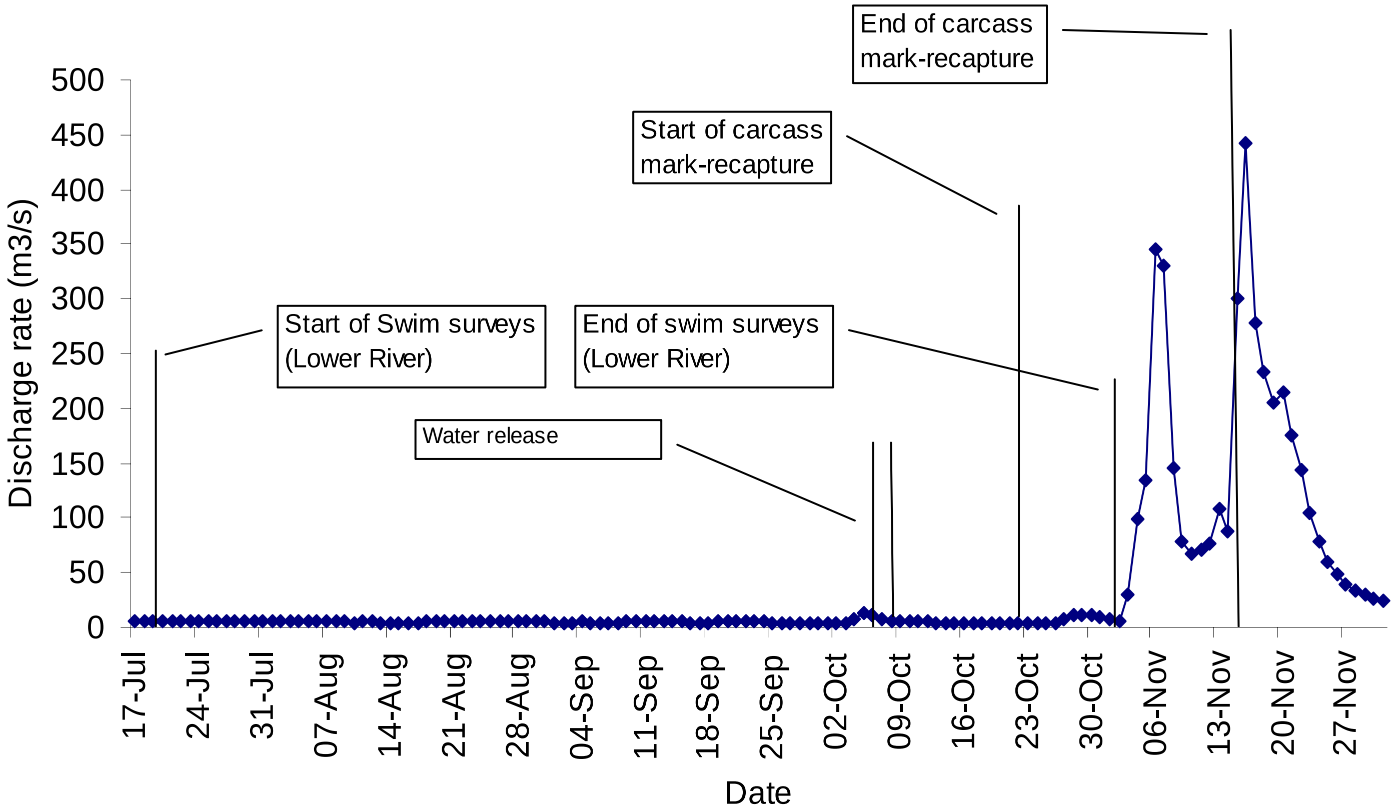


Figure 3. Daily Nanaimo River Discharge (m3/s) during the fall run chinook season, 2006. Discharge data are preliminary and subject to revision

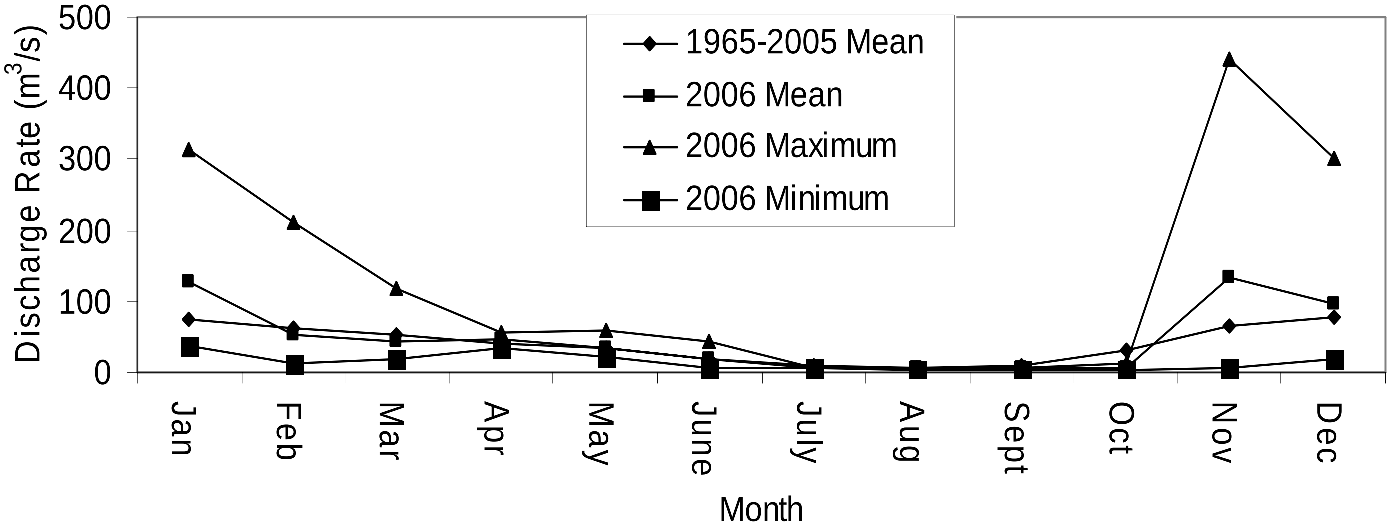


Figure 4. Monthly Nanaimo River discharge (m^3/s) in 2006 along with historic (1965-2005) mean

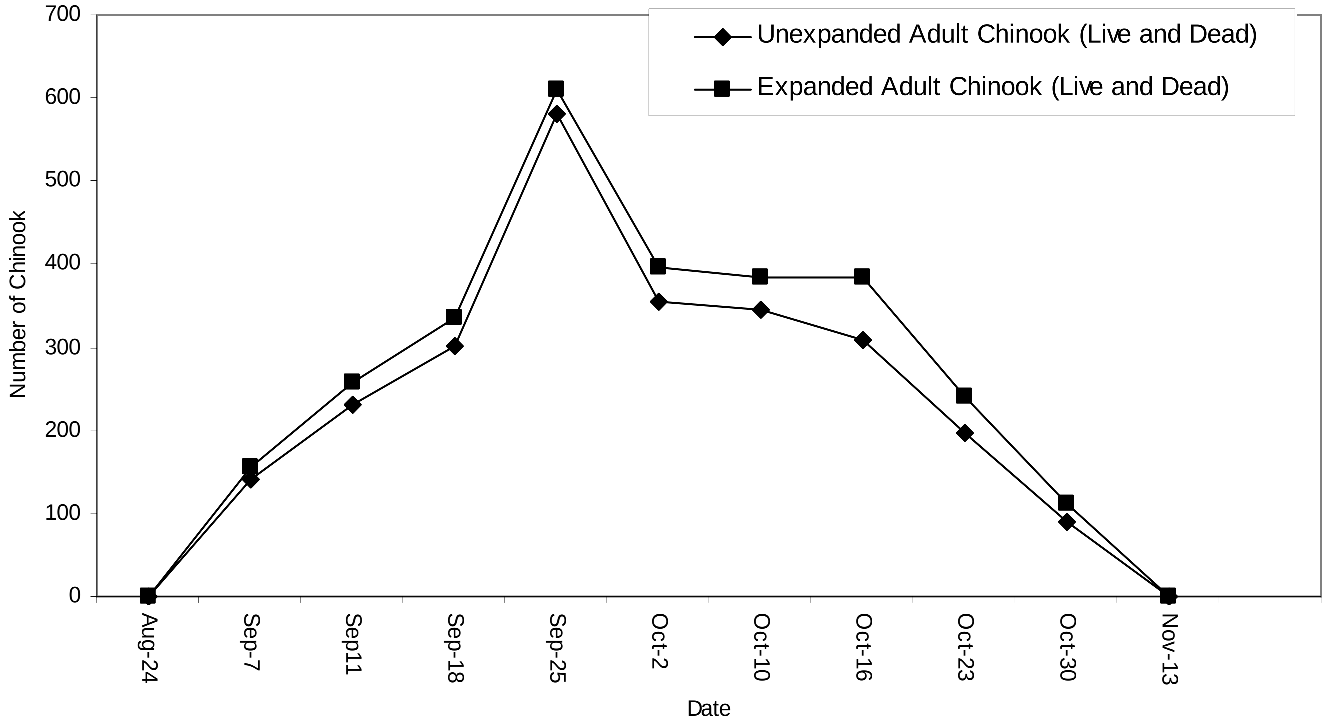


Figure 5. Expanded (for observer efficiency) and unexpanded swim survey counts, lower Nanaimo River, 2006.

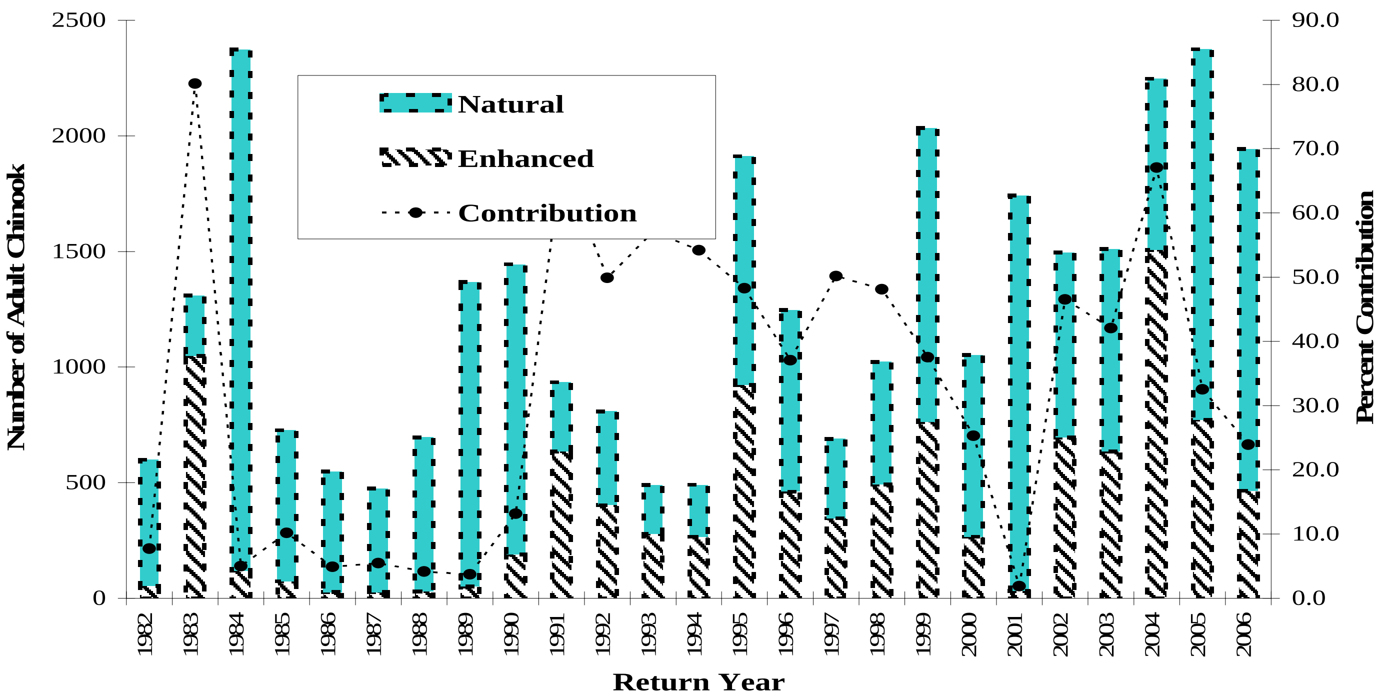


Figure 6. Annual natural and enhanced contributions to fall run chinook escapement, Nanaimo River 1982-2006

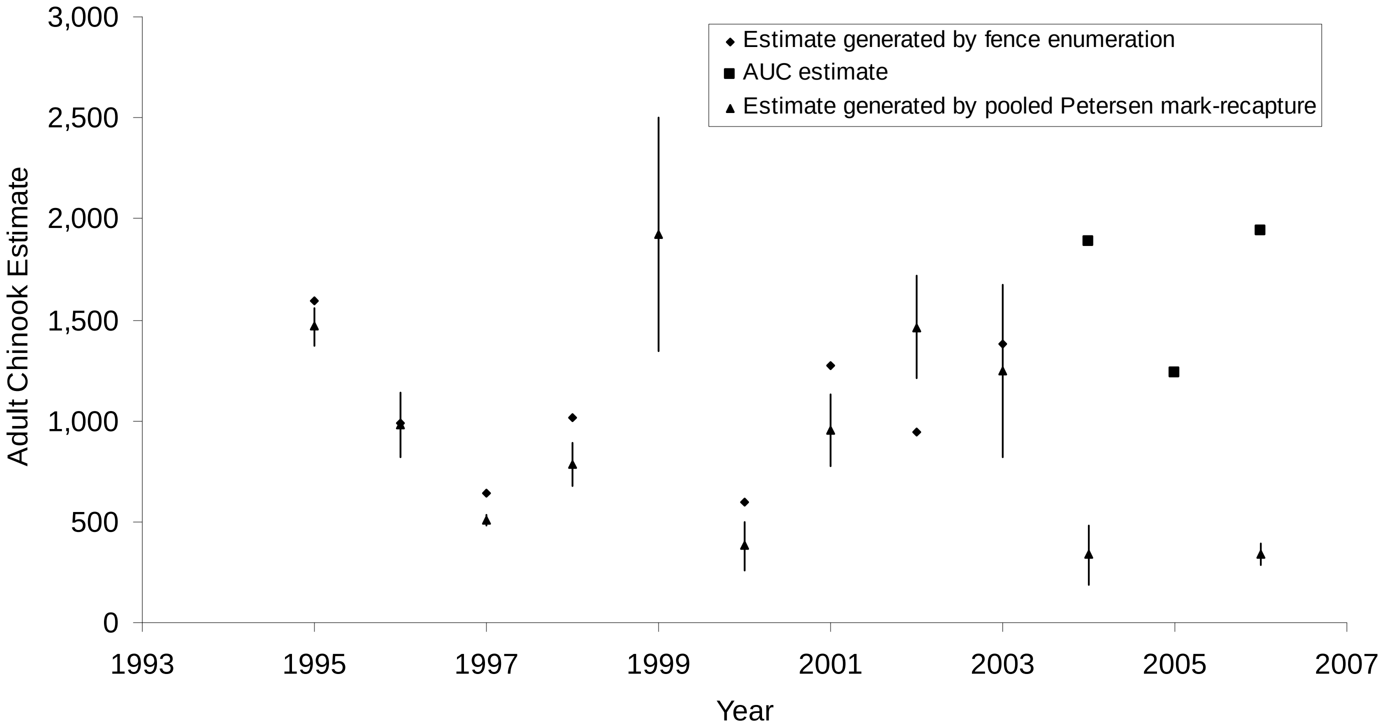


Figure 7. Annual comparisons of fall run adult chinook population estimates generated by fence information, AUC, and mark-recapture pooled Petersen calculations (with 95% confidence intervals), lower Nanaimo River, 1995 - 2006.

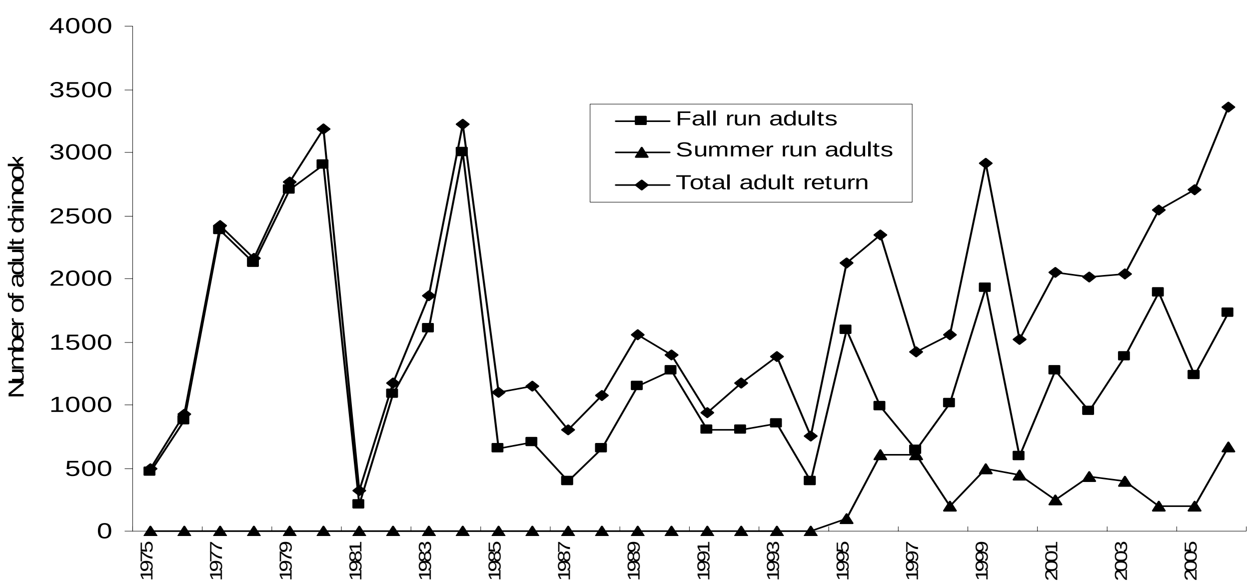


Figure 8. Annual adult chinook escapement estimates, Nanaimo River, 1975 - 2006