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Review of 1998 Terminal Run of Somass River Chinook Salmon, 1998 WCVI Extensive Escapement Indicators, and Somass Terminal Run Forecast for 1999

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Abstract

The detailed assessments and forecasts of the Robertson Creek Hatchery/Stamp River (Somass) chinook are undertaken annually for management of ocean and inlet fisheries, and as an indicator of the expected returns to the naturally spawning chinook populations along the west coast of Vancouver Island (WCVI). The following forecasts are based on returns through 1998, assumptions of ocean fishing mortality in Alaska and Canada, and using methods previously approved by PSARC.

The recommended forecast for total pre-fishery abundance of Somass/Stamp River chinook available in Canada is 76,000±20% based on averaging the Prod2 and Prod3 forecasts. This number includes both immature feeder chinook which will not mature in 1999 as well as chinook which will mature and be able to spawn in 1999.

Given internal Fishery Managers' recommendations on allocation to various fisheries, the recommended forecast for Robertson Creek Hatchery and Stamp River chinook (age 3,4, and 5) returning to Barkley Sound in 1999, is 39,000±20% based on averaging the Prod2 and Prod3 forecasts. The age structure of the return is projected to be: 13% Age 3, 11% Age 4, and 76% Age 5; with an expected sex ratio of 64% females. The number of chinook required to meet the minimum spawning escapement goal is 25,000. This goal is achievable if ocean fishing mortality is equal to or less than those assumed (footnote 1) and terminal catches do not exceed those allocated.

"Extensive" surveys of natural spawners in systems along the WCVI indicated improved chinook escapements in 1998, mainly due to strong returns from the 1994 brood. However, as with the Somass return, there was a seriously low number of age 3 chinook (1995 brood year) throughout the WCVI. This will result in low numbers of age 4 returns in 1999, which are usually the main age class in the run and the main age class in egg deposition.

In addition, indications of low age-2 male (jacks) returns in 1998 suggest a very low survival rate for the 1996 brood year (although note there can be large error in this estimate). However, two consecutive broods with poor survival could result in extreme conservation concerns in 2000. As a result, there is a continued need for conservative management plans in fisheries impacting these stocks during 1999.

Résumé

Des évaluations et des prévisions détaillées du saumon quinnat de la pisciculture de Robertson Creek et de la Stamp River (Somass) sont réalisées à chaque année aux fins de la gestion des pêches en mer et en estuaire et à titre d'indicateurs des remontées prévues des populations naturelles le long de la côte ouest de l'île de Vancouver (WCVI). Les prévisions ci-après sont fondées sur les remontées de 1998 et les hypothèses formulées pour la mortalité due à la pêche en mer en Alaska et au Canada. Elles ont été réalisées à l'aide des méthodes déjà approuvées par le CEESP.

La prévision recommandée pour l'abondance totale avant la pêche dans les rivières Somass/Stamp exploitables au Canada est de 76 000±20 % et est fondée sur la moyenne des prévisions de Prod2 et Prod3. Cette valeur comprend les saumons quinnats immatures qui ne seront pas matures en 1999 de même que ceux qui matureront et seront en mesure de frayer en 1999.

En tenant compte des recommandations internes des gestionnaires des pêches sur la répartition entre les diverses pêches, la valeur prévue recommandée pour la les saumons de la pisciculture du ruisseau Robertson et de la rivière Stamp (âges, 3, 4 et 5) retournant dans le détroit Barkley en 1999, est de 39 000±20 %, valeur basée sur la moyenne des prévisions de Prod2 et Prod3. La structure des âges des remontées prévues est de : âge 3 – 13 %, âge 4 – 11 % et âge 5 – 76 %; le rapport des sexes prévu étant de 64 % de femelles. Le nombre de saumons quinnats nécessaire pour atteindre l'objectif de l'échappée de géniteurs minimum est de 25 000. Cet objectif peut être atteint si la mortalité par pêche en mer est égale ou inférieure aux valeurs prévues (note de bas de page 1) et si les captures en estuaires n'excèdent pas les valeurs allouées.

Des relevés «exhaustifs» des géniteurs naturels dans les bassins versants de la WCVI ont montré une amélioration des échappées de saumons quinnats en 1998, qui s'explique surtout par de fortes remontées des poissons produits en 1994. Par ailleurs, comme pour la remontée de la Somass, on a noté un nombre très faible de saumon quinnat d'âge 3 (production de 1995) sur toute la WCVI. Cela donnera lieu à de faibles remontées de poissons d'âge 4 en 1999 et les poissons de cet âge sont généralement ceux de la principale classe d'âge formant la remontée, et cette classe d'âge est celle dont la ponte est la plus importante.

En outre, des indices de faibles remontées de âges de 2 ans (« jacks ») en 1998 portent à croire à un très faible taux de survie des poissons de l'année d'éclosion de 1996 (l'erreur de cette estimation pourrait cependant être importante). Par ailleurs, deux générations consécutives de faible taux de survie pourraient se traduire par des problèmes de conservation extrêmement importants en l'an 2000. Par conséquent, il s'avère nécessaire de maintenir les plans de gestion axés sur la conservation pour les pêches ayant des effets sur ces stocks en 1999.

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1 Introduction

This PSARC document uses methods previously reviewed in Riddell et al (PSARC X96-01) to forecast Somass River chinook salmon returns to Barkley Sound. This working paper includes a summary of data collection and accounting procedures used in 1998 and a forecast of the 1999 return. Historic data are not repeated but documented in PSARC X96-01.

Since the development of Robertson Creek Hatchery (RCH) in 1971, the Somass River system has become one of Canada's major producers of chinook salmon, with large contributions to ocean troll and sport fisheries, and stimulating the development of substantial terminal sport, native, and commercial fisheries.

CWT analyses for this stock indicate that during an average year (excluding 1995-1998) about 50% of the stock was harvested in ocean fisheries, and 50% returned to Barkley Sound. Over half of the ocean harvest occurred in south east Alaska fisheries (SEAK). In years of high productivity, production of chinook salmon from the Somass River system, including total terminal run plus ocean catch of hatchery fish, was over 400,000 chinook (1991 return year). This ocean catch is based on expanded coded-wire tag from the hatchery but does not account for incidental mortality in ocean fisheries, or the ocean catch of natural production from the Somass River system.

The Somass River system is located at the head of Alberni Inlet in Barkley Sound on the west coast Vancouver Island. Within this system, the Stamp River, which drains Great Central Lake, and the Sproat River, which drains Sproat Lake, combines to form the Somass River. Roughly half way up the Stamp River are a set of impassable falls, Stamp Falls. Fishways constructed to circumvent the falls are the basis for counting escapement into the upper Stamp River. Historically, naturally spawning chinook were present in the lower Stamp below Stamp Falls, the Sproat River, and the Somass River mainstem. These areas were generally poorly enumerated. However, since the development of RCH on the upper Stamp River, the majority of the spawners are now located in the upper Stamp River.

An interim spawning escapement goal was established in 1988 based on escapements immediately prior to the 1985 Pacific Salmon Treaty (PST), including:

- 70,000 naturally spawning chinook (or double the estimated 35,000 adult spawners),
- 15,000 chinook for 10 million eggs into RCH, plus a
- 20% increment to account for prespawn mortality.

Conservation concerns due to poor marine survival brought on by an extreme El Nino event in the 1992-1995 period required formulation of a minimum escapement level. This level was based on escapement prior to 1985, and included:

- 50 million egg target for natural spawning,
- 9.3 million egg target for RCH, plus the
- 20% increment to account for prespawn mortality

2 Terminal Run Calculation

The Stamp River is a key indicator for exploitation rates and distribution patterns of WCVI chinook rivers. The accounting of the terminal return into Barkley Sound (DFO Statistical Area 23) is formulated in Appendix Table 1 and summarized in Table 1. The conduct of the monitoring programs and results in 1998 are described herein.

2.1 Sport Fishery Survey

A creel survey was conducted in Alberni Inlet and Barkley Sound from mid-June to the end of September. As part of the ramp survey, 5,126 interviews (15% of the fishing effort) were conducted in Alberni Inlet and approximately 2,100 interviews (8% of the fishing effort) were conducted in Barkley Sound. For the effort survey, all sub-areas were surveyed approximately twice per week or more. Most chinooks observed during the interview process were also sampled for adipose fin clip, scales, and length, and some had otoliths removed.

The total chinook catch in Alberni Inlet was estimated to be 13,453 chinook of all origins from approximately 33,000 boat trips. Based on expanded CWT recoveries, 9223 of these chinook were Robertson Creek Hatchery origin. Another 695 chinook originated from other hatcheries, based on expanded CWT. The remaining 3535 chinook were estimated to originate from Stamp River natural spawners. In Barkley Sound, total chinook catch during the Aug.-Sept. period was 19,500 chinook from approximately 26,000 boat trips.

The terminal run calculation includes all Somass River chinooks caught in the sport fishery in DFO Statistical Areas 123 and 23 (Barkley Sound and Alberni Inlet). For the purpose of this accounting, Alberni Inlet includes waters out as far as Pocahontas Point. In Alberni Inlet, the total catch of 12,758 chinook, not includeing expanded coded wire tag (CWT) recoveries of non-Somass River chinook, was included in the terminal run calculation. In Barkley Sound, the catch of Somass River chinook was estimated as the expanded CWT in Barkley Sound / proportion RCH in the Alberni Inlet catch plus escapement (Appendix Table 1). The total catch of Somass River chinook in Barkley Sound was estimated to be 6,431 chinook.

2.2 Native Fishery Monitoring

Under an agreement between DFO and the local First Nations, Pilot Sales fisheries targeting chinook salmon were conducted in the lower Somass River below Papermill Dam (the tidal limit). Gear was limited to hand set gill nets, mainly using 7-inch mesh size. Fisheries were conducted August 31 and September 1. Total catch was estimated by a census of fishers as they landed at designated landing sites and assumed that all fishers were encountered. The total catch in 1998 was estimated to be 7,172 chinook.

Biological sampling was conducted on a portion of the catch as it was transferred to buyer's totes or as it was unloaded at the processing plant. In all, 1007 chinook (14% of the total catch) were sampled for mark incidence. Scales, sex, and length were taken from 315 chinook.

2.3 Stamp Falls Fishway Observations of Total Escapement

Monitoring of salmonid migration through Stamp Falls fishway ran from September 2 until November 10, 1998. A snorkel survey was conducted above Stamp Falls on September 2 to determine the number of chinook already in the system above the counting facility at Stamp Falls.

Observations at Stamp Falls fishway counting facility were conducted for about 14 hours per day from September 2 to 17 from approximately 0.5 hour before sunrise to 0.5 hour after sunset. From September 18 to October 25, observations to take place for 24 hours/day, as part of the Barkley Sound Selective Fishery Program, which required enumeration of Spaghetti tags at the fishway. From October 26 to November 10 observation was reduced to 12 hours/day and the fishway was closed to migration for the night-time period. This ensured no migration could occur unobserved.

Early in the season, before 24 hour counting, a mechanical counter was installed to determine night time migration. This showed limited fish movement during this period. However, this migration was difficult to quantify in terms of both species and numbers. The daytime migration at that time was primarily sockeye and coho but with some chinook.

Later in September and early October, during the 24 hour observations, up to 50% of all chinook observed during any 24 hour period were migrating at night. However, this night time migration may not be indicative of natural night time migration. It may be a result of the artificial lights being used in the fishway or because of the high densities of fish in the fishway. It was noted that once the chinook moved into the lit area of the fishway they were reluctant to exit into the darkened river. A build up of fish occurs at the exit of the fishway even during daylight hours but not to the same extent as that observed at night. Nighttime migrants were therefore assumed to be sockeye and coho with a few chinook. However, because migration rates for chinook were so low during this period, even if 50% of all chinook were migrating at night during this period it would not significantly affect the overall estimate of chinook escapement.

Low flows and high water temperatures in the Stamp River resulted in unusual run timings for salmonids during 1998. A large and very late component of the Great Central Lake sockeye run combined with the largest recorded return of coho into the Stamp River resulted in high densities in the fishway and entrance to the fishway from mid September until around mid October. It appeared from ground level observations, that the majority of the chinook run stayed in the deeper and cooler waters of Stamp Canyon until early October. Chinook were observed in poor condition with fungal infections. Visual estimation using snorkel and dive surveys below Stamp Falls in late October/early November estimated approximately 4,000 chinook in poor shape and unlikely to make it through Stamp Falls fishway. These chinook did not show up in subsequent observations at the fishway. Surveys also indicated that some chinook were digging redds below Stamp Falls.

Significant changes were made to the setup from previous years in an attempt to improve visibility during high water and silty flow conditions. A video camera was mounted vertically above the counting tunnel and above the water. This reduced the column of water through which filming/observations had to be made from about 36 inches to 12. A mirror was placed beneath the camera and at a 45° angle behind a sheet of plexiglass which divided the observation box lengthwise. This enabled the fish to be observed from above in half the image and a reflection of the side of the fish in the other half. The viewing box and camera were covered with heavy black plastic to eliminate the reflection of light from above. Underwater lights were placed in the box to provide light for the camera and observers. A number of different lighting setups were tried before a satisfactory one was found. The modified setup worked very well and no time was lost as a result of poor conditions. However, conditions were excellent for most of the migration period so the new setup was not tested under adverse conditions.

Observations were conducted in real time through a 21inch high-resolution colour monitor. A Super VHS time lapse VCR simultaneously recorded the migration. Observations were entered into a customised MSAccess program on a laptop PC. Time, date, observer, species, direction of migration, maturity (adult or jack) and adipose clip data was recorded for each fish as it passed by, along with any comments. Any chinook of 59cm or less ‘total’ length was considered to be a jack and was determined by using reference markings on the base and back of the tunnel. The time lapse VCR provided excellent image quality and left a time/date stamp on the image. Synchronised times between the VCR and the Stamp Falls database enabled comparison of the ‘real time’ observations entered into the database with subsequent verifications.

Observer error was estimated from verification of 100 randomly chosen hours of tape. Verifications were conducted by experienced observers from the Stamp Falls fishway. They were entered into the same MSAccess database as for the ‘real time’ events. The video tape was slowed down, paused or replayed where there was any difficulty in determining either the species or the number of fish passing through the observaion box. Results from verifications were considered to be a true reflection of the migration .

Linear regression was used to compare the verification with the 'real time' observations. Results indicated that the best predictor for adult chinook was, as expected, adult chinook. However, the results showed that the best predictor of jack chinook was also 'adult chinook'. This indicates that there is poor recognition of jack chinook by observers at Stamp Falls. Therefore, the ratio of jack chinook to adult chinook in the verifications was applied to the adjusted adult return to estimate the jack chinook return to the Stamp River in 1998.

The total observed counts at Stamp Falls were corrected using the following relationships between verified (V) and real time (RT) counts:

Chinook adults: $CNAD_{adj} = RT \times 1.0492$ $r^2=0.889$, d.f. = 93

Chinook jacks: $CNJK_{adj} = CNAD_{adj} \times (\Sigma V_{cnj}/\Sigma V_{cnad})$

Where: $CNAD_{adj}$ = adjusted chinook adult count

$CNJK_{adj}$ = adjusted chinook jack count

ΣV_{cnj} = sum of verified chinook jacks

ΣV_{cnad} = sum of verified chinook adults

A minor component of the chinook return is not accounted for as a result of any bypass of the fishway (up Stamp Falls) and night time migrants from September 2 to 17. The night time component is probably minor and significantly less than past years as a result of night time observations for much of the migration period and closing the fishway during the end of the run. Bypass is difficult to quantify. Many salmon, mostly coho but some chinook, were observed part way up Stamp Falls, well above the entrance to the fishway. However, very few fish were observed successfully making it past the more difficult upper portion of the falls. It is thought that the majority of fish making it part way up the falls eventually drop back down and enter the fishway.

2.4 Sampling at Robertson Creek Hatchery

In 1998, the hatchery intake was left open, allowing 12,961 chinook to enter Robertson Creek Hatchery, including 5189 females (40% of the total). All fish entering the hatchery were counted, checked for AFC, and recorded by sex. Jacks were separated from larger chinook based on a length of 50-cm post orbital hypural (POH) length. The age composition of the total return to the hatchery was based on two independent samples for each sex, ages from CWT's of adipose clipped fish and random scale samples from unmarked fish. Sample data are summarized in Appendix Table 2. Age composition for each sex was estimated by pooling the number at age in the estimated CWT and scale samples.

2.5 Sampling on Spawning Grounds

Sampling of carcasses in the Stamp River was conducted by 4 people working 5 days per week, from October 5 through November 10. Water levels were moderate and no time was lost as a result of high flows/dangerous conditions. The objectives included sampling as many fish as possible for adipose fin clips (AFC), and biological sampling (including scales, otoliths, POH length, sex, egg retention level) of about 500 chinook per sex and all jacks. Samples were collected using a carcass weir and by searching for and gaffing carcasses along river banks/bars using a jet boat. Tails were severed from all fish sampled.

In 1998, 6282 chinook were sampled for AFC, with 197 recoveries. Biological samples were taken from 555 adult males, 17 jacks and 545 females. Sample data are summarized in Appendix Table 2.

The total in-river escapement was determined by subtraction of the hatchery count from the adjusted fishway count. In addition, an estimated 4,000 prespawn mortality chinook were observed by visual snorkel surveys below the Stamp Falls fishway. It was assumed that these chinook did not make it through Stamp Falls as a result of the high temperatures and low flows. Sample sizes of adult males and jacks in the river are unlikely to be representative of their population sizes due to the post spawning behaviour of males and the absence of small males in the dead pitch. The in-river sex ratio was therefore estimated as the unweighted average of the hatchery sex ratio and the sex ratio for dead pitch sampling in the river.

The in-river population was stratified into males, females, and jacks in the following way:

In-river count = Adjusted total fishway count + estimate below S. Falls - total hatchery count
Total river males (TRM) = in-river count x unweighted sex ratio
River females = in-river count - TRM
River jacks = $CNAD_{adj}$ x $(\Sigma V_{cnj}/\Sigma V_{cnad})$
Adult river males = TRM - river jacks

Age composition by sex was estimated in the same way as for the hatchery samples.

2.6 Total Estimated Terminal Run

The terminal run was defined as catch in DFO Statistical Area 23, including catch of Somass River and RCH chinook in native, sport, and commercial fisheries, plus spawning escapement to the Stamp River.

Table 1a. Summary of 1997 terminal run of Somass River chinook.

Fishery	# Age 2	# Age 3	# Age 4	# Age 5	# Age 6	Total
Alberni Inlet Sport	72	388	11,523	775	0	12,758
Somass Native	0	79	6,268	796	29	7,172
Barkley Sound Sport	85	145	5,805	389	26	6,431
Hatchery Returns	29	653	10,883	311	0	11,876
River Escapement[1]	219	1,071	27,993	1,895	0	31,178
Total Terminal Run	386	2,394	63,470	4,195	55	70,500

[1] Includes prespawn mortalities plus river spawners

Overall, the terminal run was within 16% of the forecast. The age 4 component of the total terminal run was 33% greater than forecast, while the age 3 return was approximately 50% less than the low number forecast. Female spawners in the river totalled approximately 8,300 which produced a deposition in the river of approximately 37 to 51 million eggs, or approximately 80% to 100% of the predicted number, depending on the level of prespawn mortality included. Another 4,700 females swam into the hatchery and were utilised there. Based on expanded CWT data, the estimated proportion of hatchery fish in the total terminal catch was 65% and 66% of the chinook spawners in the Stamp River.

Table 1b. Summary of total return from hatchery production only, based on expanded CWT.

Fishery	# Age 2	# Age 3	# Age 4	# Age 5	# Age 6	Total
Alberni Sport	0	153	8,342	728	0	9,223
Somass Native	0	154	3,052	414	0	3,620
Barkley Sound Sport	0	389	3,860	0	0	4,249
Total Terminal Catch	0	696	15,254	1,142	0	17,092
Hatchery	47	396	7,940	240	0	8,624
River	0	477	20,746	37	0	21,261
Total Terminal expCWT	47	1,569	43,940	1,419	0	46,977

3 Analytical Framework

3.1 Cohort Analyses

Cohort analysis is conducted using 'estimated' CWT recoveries, in all fisheries and total escapement (including hatchery swim-ins and natural spawners), to determine survival rates and exploitation patterns for Robertson Creek Hatchery chinook. The incorporation of in-river tag recoveries provides estimates of the true total exploitation rates for this stock. The cohort model used is documented in Appendix 2 of Starr and Argue (1991) and as modified by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission (PSC, TCCHINOOK (98)-1). In determining incidental mortality, only the brood year method was used. The cohort model was modified by the CTC to account for the chinook non-retention fisheries implemented in Canada during 1996. Modifications are documented by the CTC in Appendix G of TCCHINOOK (98)-1.

For each brood year, information used from the cohort analyses include:

- annual distribution of catch and total fishing mortalities;
- survival of CWT groups to age 2 recruitment; and
- ocean (catch or total fishing mortality) and total exploitation rates by fishery and age.

3.2 Forecasting Models

Sibling regression models have been developed to predict total production from selected tag codes based on production observed from younger age classes in these tag codes (including total ocean fishing mortality plus total terminal run for brood years used in the cohort analyses). Total production was calculated by multiplying the brood releases (for the selected tag codes) by the estimated total fishing mortality exploitation rates derived by the cohort analysis. Tag codes used are listed in Appendix 4.

Two combinations of terminal run and total production data have been used in the sibling regression models. Note that the first model developed in 1995 (i.e., Model 1 - Prod1), based on regressing total terminal return at one age class to total terminal return at a subsequent age class is not used since constant ocean fishing mortality rates must be assumed between years.

- Model 2 (Prod2). This regression model uses total terminal return at a younger age class (independent variable) to predict total production (the surviving cohort in the ocean) of a subsequent age or ages from the same brood year. The dependent variable is the total (total ocean fishing mortality plus terminal run) production at a subsequent age or ages.
- Model 3 (Prod3). This regression model uses estimated total production (total fishing mortality plus

escapement) of an age class(es) to predict total production of subsequent ages (i.e., the surviving cohort) from the same brood year.

Relationships between all possible age class combinations were examined using these two models. The actual models used for the forecast were based on the highest r^2 values. In the case where more than one age class is used, such as the total terminal run of age 2+3, the total terminal runs at age 2 and age 3 were summed. Estimates of surviving cohort include natural mortality factors and are estimated as the pre-fishery abundance of the youngest age being predicted. All regressions were forced through the origin.

3.3 Spreadsheet Model

A spreadsheet model was developed to: 1) expand predicted hatchery production (expanded CWT) to total production; 2) determine the number of mature adults returning to southern B.C.; 3) examine response in terminal runs to changes in ocean harvest rates by fishery and age.

Inputs to the spreadsheet include: estimated hatchery production (expanded CWT all tagcodes) in terminal runs by age and year, observed total terminal runs by age and year, and the forecasted age 3, 4, and 5 hatchery cohort abundance. Each regression forecast is expanded for total Somass system production to account for hatchery production not associated with the tag codes selected, as well as production from naturally spawning chinook. Expansion scalars are estimated within brood years and by age. These scalars are the ratio of total terminal run (hatchery plus natural) divided by the terminal run of tagged hatchery releases (expanded CWT). This expansion assumes that natural production from the Stamp River exhibits similar behaviour and encounters similar fishing pressure as the hatchery stock.

Other components of the spreadsheet include average total mortality exploitation rates by age and fishery, maturity rates and natural mortality rates by age; and matrices of 'fishery management scalars'. These scalars are used to simulate management actions in the fisheries, and allow examination of alternative actions. Cohorts are harvested in ocean and terminal fisheries and/or allowed to become spawners. Predicted spawning escapement is compared to target reference points.

The surviving immature cohort is passed on to the next age in year i+2. Age 3 cohorts for year i+2 were estimated from average or recent average age 3 survival values (derived from the cohort analysis) times the smolts released in year i-3, and then expanded by average brood year scalars to account for natural production.

3.4 Forecast Error

A retrospective assessment of the forecasting methodology was presented in PSARC S96-01, for years 1988 through 1995. Including the information up to and including the current forecast in this assessment, produces an updated estimate of the prediction error. The assessment uses a "leave-one-out" methodology. Each regression model is re-calculated while omitting each data point (one year) once. The omitted data point is then used as the observed value and the predicted value compared to the observed. Average absolute deviations are used as the forecast error expected for each model.

4 Results and Forecast for 1999

4.1 Cohort Analyses

Cohort analyses for the 1983 through 1996 brood releases from Robertson Creek Hatchery were completed using the total escapement of coded-wire tags to the hatchery and the natural spawning grounds in the upper Stamp River. Returns from the latter 3 broods are incomplete through 1998 and are estimated using average maturation rates from the completed brood returns. Recoveries from the 1992 brood year are very limited (estimated number of recoveries = 10) and the cohort analysis is not reliable. However, for the nine brood years (1983 through 1991) for which total escapement recoveries are available, the total exploitation rates (expressed as adult equivalents to account for changes in size limits over time) have averaged:

ocean total mortality exploitation rates = 44.6% (CV = 13%)
(ocean implies non-terminal fisheries, outside Barkley Sound), and
brood total mortality exploitation rates = 65.7% (CV = 6%).

Returns from the 1993 brood year indicate significant reduction in exploitation rates (estimated ocean exploitation rate = 37% and total exploitation rate = 51%) as expected due to the conservation actions taken during 1995 through 1998.

Estimates of marine survival continue to demonstrate highly variable survival and very poor survival for the most recent brood years, 1995 and 1996 (Table 2).

Annual distribution of the total fishing mortality on the Robertson Creek stock has been up-dated through 1998. Conservation actions taken in recent years are again evident in distribution changes (Table 3) and the continued reduction in total fishing mortality.

Table 2. Estimated survival rates (smolts released to Age 2 chinook) of coded-wire tagged (CWT) groups released from Robertson Creek Hatchery by brood years. Survival to Age-2 cohort include all recoveries, estimated incidental fishing mortality, and annual rates of natural mortality for all ages (Ages 2 through 5). Survival rates of Age-2 chinook only include recoveries of Age-2 chinook.

Brood Year	Estimated % Survival Rate for CWT groups:	
	Age-2 cohort	Age-2 chinook
1983	0.10	0.0114
1984	4.42	0.1314
1985	4.32	0.1443
1986	12.05	0.4161
1987	10.30	0.4909
1988	13.09	0.6012
1989	9.21	0.4096
1990	5.56	0.2000
1991	0.99	0.0460
1992	0.01	0.0002
1993	2.22	0.0770
1994	5.26*	0.0756
1995	0.31*	0.0043
1996	0.18*	0.0031

Notes: * these broods have incomplete recoveries but are estimated based on observations to-date and assuming average maturation rates from completed brood years.

4.2 Production-based Forecast Models

Table 4 summarizes the results of Prod2 (terminal run vs. total production) and Prod3 regression models. The upper portion of these tables identify each sibling model, the x-value used in the 1998 forecast, the predicted value and its upper and lower 90% confidence bounds, the co-efficient of the regression (intercept is zero), the r-squared value, and sigma (residual standard deviation of the regression). Asterisks identify regressions used in the 1998 forecast. Results of the retrospective assessment of each forecasting equation are also presented in the lower portion of tables. For each brood year, the observed and predicted values are presented. The mean absolute deviation (estimated prediction error) varied between 42% and 86% of the known data value for the Prod2, and 25% to 50% for the Prod3 model.

Table 3. Distribution of total fishing mortality for Robertson Creek Hatchery chinook stock; distributions based on cohort analysis through 1997 and using the brood year method to estimate incidental fishing mortality. Some fisheries with very few recoveries have been combined, e.g. Southern nets and other sport include southern BC and Washington recoveries.

	Fishing Mortalities by Major Fishery, as a proportion of Total Fishing Mortalities plus Escapement															
Catch Year	Alaska Troll	north BC troll	central BC troll	WCVI troll	Alaska Net	NCBC net	south BC net	south US net	Alaska sport	NCBC sport	WCVI sport	Other sport	Terminal net	Terminal sport	Total Ocean Fishing Mortality	Total Fishing Mortalities	Escape-ment
1985	5.1%	0.0%	1.0%	3.2%	0.0%	0.8%	0.0%	0.0%	0.0%	2.6%	0.0%	21.7%	0.0%	0.9%	34.3%	35.2%	64.8%
1986	14.0%	8.2%	1.9%	6.7%	6.4%	5.3%	1.9%	0.6%	1.5%	1.4%	4.3%	2.9%	0.8%	15.2%	55.0%	71.0%	29.0%
1987	10.6%	7.7%	3.1%	3.1%	3.6%	2.4%	1.0%	0.4%	0.5%	0.6%	0.5%	0.7%	0.3%	19.9%	34.3%	54.5%	45.5%
1988	12.9%	8.8%	1.6%	4.7%	4.3%	1.8%	0.2%	0.3%	1.1%	1.2%	4.5%	0.8%	7.0%	12.8%	42.1%	61.9%	38.1%
1989	14.3%	9.0%	1.4%	3.3%	5.5%	1.0%	1.0%	0.1%	1.3%	1.0%	1.6%	0.8%	15.8%	14.6%	40.3%	70.6%	29.4%
1990	19.4%	8.8%	2.5%	7.6%	4.4%	1.5%	0.6%	0.0%	1.4%	1.0%	1.9%	0.4%	8.2%	7.8%	49.3%	65.3%	34.7%
1991	19.7%	9.5%	2.8%	6.0%	2.5%	0.6%	0.6%	0.0%	2.2%	0.8%	1.1%	0.4%	12.8%	12.1%	46.2%	71.1%	28.9%
1992	17.1%	7.4%	2.8%	17.9%	7.8%	0.8%	0.3%	0.1%	1.3%	1.4%	2.0%	0.2%	0.4%	5.4%	59.1%	64.9%	35.1%
1993	16.3%	7.3%	2.0%	13.6%	2.2%	0.4%	0.8%	0.0%	2.6%	1.4%	2.5%	0.6%	6.9%	12.9%	49.7%	69.5%	30.5%
1994	18.3%	9.4%	1.1%	5.4%	4.8%	1.0%	0.2%	0.0%	3.7%	1.2%	7.5%	0.5%	3.1%	19.2%	53.0%	75.4%	24.6%
1995	16.8%	3.4%	0.4%	1.6%	0.1%	0.4%	0.1%	0.2%	4.2%	1.3%	5.8%	1.3%	6.3%	11.8%	35.6%	53.7%	46.3%
1996	14.7%	3.2%	0.7%	1.9%	1.7%	0.1%	0.0%	0.0%	1.7%	2.4%	1.5%	1.5%	0.2%	2.9%	29.3%	32.4%	67.6%
1997	13.7%	5.0%	1.8%	0.1%	7.0%	0.4%	0.1%	0.0%	4.0%	2.5%	2.0%	0.6%	5.8%	16.9%	37.4%	60.1%	39.9%
1998	18.7%	5.9%	0.1%	0.0%	4.1%	0.0%	0.0%	0.0%	0.0%	1.8%	4.8%	0.5%	4.0%	17.2%	35.9%	57.0%	43.0%
Average																	
1985-94	14.8%	7.6%	2.0%	7.1%	4.1%	1.6%	0.7%	0.1%	1.6%	1.3%	2.6%	2.9%	5.5%	12.1%	46.3%	63.9%	36.1%
1995-98	15.9%	4.4%	0.7%	0.9%	3.2%	0.2%	0.1%	0.1%	2.5%	2.0%	3.5%	1.0%	4.1%	12.2%	34.5%	50.8%	49.2%

Table 4. Regression equations and results for Robertson Creek forecast models.

PART A: TERMINAL RUN vs. TOTAL PRODUCTION REGRESSIONS (PROD2 MODELS)

Model # and description	Predictor x-value	Prediction	90% confidence interval lower	upper	para.value (slope)	r-square	sigma
#3, Age 2 vs. Ages(3+4+5)	257	6688.75	-121576.09	134953.59	26.03	.92	70765.56
#5, Age (2+3) vs. Ages (4+5)	1655	5611.63	-33166.94	44390.20	3.39	.98	21393.93
#6, Ages (2+3+4) vs. Age 5	63680	27447.19	13587.03	41307.35	0.43	.97	7476.29
#7, Age 3 vs. Ages (4+5)	1580	6453.56	-42643.62	55550.74	4.08	.96	27085.79
#8, Ages (3+4) vs. Age 5	62735	29843.12	16302.14	43384.10	0.48	.97	7275.23

Mean absolute deviations by model:

	Sum of Square error
Age 2 vs. Ages(3+4+5)	.8020
Age (2+3) vs. Ages (4+5)	.4916
Ages (2+3+4) vs. Age 5	.7055
Age 3 vs. Ages (4+5)	.4958
Ages (3+4) vs. Age 5	.6176

Leave-one-out Assessment (one forecast for each brood year by model type)

	MODEL #3 OBS.	PRED.	MODEL #5 OBS.	PRED.	MODEL #6 OBS.	PRED.	MODEL #7 OBS.	PRED.	MODEL #8 OBS.	PRED.
1983	2604	15752	1300	3255	211	778	1277	1450	211	571
1984	147862	92903	79592	117905	18777	30134	77527	128435	18777	31625
1985	141639	132076	85832	87747	22257	28159	83384	84900	22257	28664
1986	405832	241632	243990	226347	80671	61074	235116	237807	80671	63565
1987	321910	426517	187480	175086	53152	49827	181633	146657	53152	47486
1988	463603	490500	269082	294968	65853	77761	261838	271652	65853	75920
1989	240936	294218	145636	111266	35580	36800	141722	89330	35580	35240
1990	186542	53249	111329	84161	32270	25982	107779	93391	32270	27768
1991	32540	46457	17752	15456	3404	5805	17378	11335	3404	5557
1992	524	0	263	661	195	101	242	796	195	111
1993	59270	48390	30880	63213	4243	14001	30413	68726	4243	14572
1994	2604	15752	1300	3255	211	778	1277	1450	211	571
1995	147862	92903	79592	117905	18777	30134	77527	128435	18777	31625

Table 4 (continued)

PART B: TOTAL PRODUCTION vs. TOTAL PRODUCTION REGRESSIONS (PROD3 MODELS)

Model # and description	Predictor x-value	Prediction	90% confidence interval lower	upper	para.value (slope)	r-square	sigma
#3, Age 2 vs. Ages(3+4+5)	257	2332.03	-68955.70	73619.76	9.07	.97	39331.83
#5, Age (2+3) vs. Ages (4+5)	3401	5340.60	-20232.37	30913.57	1.57	.99	14108.59
#6, Ages (2+3+4) vs. Age 5	105225	21706.95	6398.42	37015.49	0.21	.96	8325.77
#7, Age 3 vs. Ages (4+5)	3053	6539.25	-17711.57	30790.08	2.14	.99	13378.63
#8, Ages (3+4) vs. Age 5	99720	23907.48	9120.41	38694.56	0.24	.96	8018.43

Mean absolute deviations by model:

	Sum of square errors
Age 2 vs. Ages(3+4+5)	.4690
Age (2+3) vs. Ages (4+5)	.2865
Ages (2+3+4) vs. Age 5	.5685
Age 3 vs. Ages (4+5)	.2702
Ages (3+4) vs. Age 5	.5140

Leave-one-out Assessment (one forecast for each brood year by model type)

	MODEL #3		MODEL #5		MODEL #6		MODEL #7		MODEL #8	
	OBS.	PRED.	OBS.	PRED.	OBS.	PRED.	OBS.	PRED.	OBS.	PRED.
1983	2604	9674	1300	3211	211	642	1277	2097	211	490
1984	147862	102038	79592	94361	18777	24653	77527	105078	18777	25975
1985	141639	108630	85832	72519	22257	22178	83384	73301	22257	22911
1986	405832	302758	243990	205540	80671	54016	235116	210220	80671	55355
1987	321910	369271	187480	202451	53152	52646	181633	188800	53152	51526
1988	463603	524848	269082	297001	65853	85410	261838	278850	65853	84345
1989	240936	279974	145636	139524	35580	40826	141722	124799	35580	39992
1990	186542	153230	111329	100634	32270	28679	107779	101146	32270	29304
1991	32540	36832	17752	22635	3404	5860	17378	22178	3404	5836
1992	524	145	263	331	195	53	242	418	195	58
1993	59270	49023	30880	41028	4243	10825	30413	44410	4243	11284
1994	2604	9674	1300	3211	211	642	1277	2097	211	490
1995	147862	102038	79592	94361	18777	24653	77527	105078	18777	25975

4.3 Spreadsheet Model

The predicted abundances shown in Table 4 are based on CWT, so represent hatchery production only. The "total" production of Stamp River chinook is determined by expanding the predicted hatchery return in Table 4 to account for hatchery production not associated with the CWT used in the regression analyses and "natural" production from the Stamp River. The expansion factors used in this forecast were 8.51, 1.63, and 1.51 respectively for the age 3+4+5 cohort, age 4+5 cohort, and the age 5+ cohort. The total cohort size available to ocean fisheries is presented in Table 5 as "Pre-fishery Abundance".

Next, fishery management scalars are applied to fisheries in Alaska based on fishing patterns expected (based on the Pacific Salmon Treaty rules or other discussions and negotiations). The remaining cohort is identified as the expected abundance into Canada (see Table 5). While all these fish are available to northern fisheries, only the mature migrating component of this total is available to southern B.C. fisheries.

Table 5. Summary of forecasted abundance and terminal run size of Somass/Stamp River chinook salmon. Expected abundance into Canada assumes fishing patterns in Alaska similar to 1998. Expected terminal run size (into Statistical Area 23) and expected escapement assumes catch and allocation patterns outlined by fisheries managers.

	Pre-Fishery Abundance	Expected Abundance into Canada	Expected Terminal Run Size	Expected Escapement
1. Model Prod 2 (Terminal vs Total Production)				
1996 brood	55,000	52,100	8,200	4,800
1995 brood	9,100	7,800	4,200	2,800
1994 brood	45,100	36,700	32,700	21,900
Total	109,200	96,700	45,000	29,500
2. Model Prod 3 (Total vs Total Production)				
1996 brood	19,200	18,200	2,800	1,700
1995 brood	8,700	7,400	4,000	2,600
1994 brood	36,100	29,400	26,200	17,500
Total	64,000	55,000	33,000	21,800
3. Average of Prod2, Prod3				
1996 brood	37,000	35,100	5,500	3,200
1995 brood	8,900	7,600	4,100	2,700
1994 brood	40,600	33,000	29,500	19,800
Total	86,600	75,700	39,000	25,700

Next, management scalars (i.e., proxy for management actions) are applied to average exploitation rates in Canadian fisheries. These scalars are determined in consultation with Fisheries Managers and reflect conservation and allocation requirements for Stamp/Somass River chinook. The resulting terminal run forecast can vary depending on the model used, the scalars used to expand the hatchery production to total Somass production, and management actions in ocean fisheries. Forecasts of total terminal run to Barkley Sound are presented for both Prod2 and Prod3 models in Table 5. Expected Stamp River escapement, after allocation to terminal area fisheries using management scalars, is also presented in Table 5.

Forecasts for the 1999 terminal run to Statistical Area 23, range from 33,000 to 45,000 (average is 39,000), based on 1999 expected ocean exploitation rates from planned fisheries in Alaska and British Columbia[1] and final estimates of the stock composition in fisheries (Chinook Technical Committee model calibration 9902).

When the age-specific forecasts are combined to predict the total terminal run to Barkley Sound, the forecasting error is, on average, less than for the individual regression models. Figure 1 compares the annual deviations from observed total terminal runs for the Prod2 and Prod3 models. Over the period 1988 to 1998, the models average 1 to 2% error in the forecast. However, when the forecast error is expressed as the average absolute deviation from annual forecasts, the average error increases to 25% for Prod2 and 20% for Prod3. On an annual basis, the forecasted terminal runs can be expected to vary by ±20% to ±25% of the forecast value.

4.4 Escapement Goal

The escapement goal for 1999 is consistent with the minimum target accepted by PSARC in 1994 (PSARC Advisory Doc. S94-1). The minimum egg requirement for hatchery and natural spawners in the Stamp River is 50 million eggs from natural spawners plus 9.3 million eggs required for Robertson Creek Hatchery. The escapement required to provide 60 million eggs is determined using Excel solver, given the age composition, fecundity, proportion females, and prespawn mortality parameters outlined in Table 6. The required escapement is estimated to be 25,000 chinook.

Table 6. Derivation of the number of spawners needed to meet the minimum egg requirements in the 1998 chinook return.

	Age composition	**Fecundity**	**Proportion Female**	**Prespawn Mortality**	**Eggs**	**Spawners**
1996 brood	13%	4000	5%	20%	0.5 million	3,375
1995 brood	11%	4400	50%	20%	4.8 million	2,725
1994 brood	76%	4800	75%	20%	54.7 million	18,980
Total					60 million	25,000

4.5 Recommended Forecast

The recommended forecast for abundance of Somass/Stamp River chinook available in Canada is 76,000±20% based on averaging the Prod2 and Prod3 forecasts. This number includes both immature feeder chinook which will not mature in 1999 as well as chinook which will mature and be able to spawn in 1999.

Assuming the fishery allocation scenario outlined in the July 23 memo to P.S. Chamut[1], the recommended

[1] Memo from Director-General Pacific Region to P.S.Chamut, Assistant Deputy Minister Fisheries Management, 23 July 1999, “Conservation measures for WCVI chinook and allocation of Somass and North Coast chinook in Canadian fisheries in 1999.

forecast for the total terminal run of Robertson Creek Hatchery and Stamp River chinook (age 3,4, and 5) to Barkley Sound in 1999, is 39,000±20% based on averaging the Prod2 and Prod3 forecasts. The age structure of the return is projected to be: 13% Age 3, 11% Age 4, and 76% Age 5; with an expected sex ratio of 64% females. The number of chinook required to meet the minimum spawning escapement goal is 25,000. This goal is achievable if ocean fishing mortality is equal to or less than those assumed (footnote 1) and terminal catches do not exceed those allocated.

5 *Extensive* escapement indicators for WCVI chinook

5.1 Survey Methods for "Extensive" Escapement Indicators

The detailed assessments and forecasts of the Somass system (RCH/Stamp) chinook are undertaken annually for management of that major stock plus as an indicator of the expected returns to the naturally spawning chinook populations along the west coast of Vancouver Island (WCVI). Seven populations on the north-west of Vancouver Island (NWVI), Areas 25 to 27, are, in aggregate, used by the Pacific Salmon Commission (PSC) to indicate trends in escapement to naturally spawning chinook along the WCVI. These are termed "extensive" escapement indicators based on the consistent effort and methodology used. Additionally, since 1995 an additional 15 "extensive" WCVI indicator streams have been surveyed for naturally spawning chinook (Table 7).

Since 1995, the snorkel method has been used to survey escapement to the "extensive" PSC indicators and the additional indicator streams. Surveys are scheduled approximately every 7 days on these systems, although weather and water flows often affect this scheduling. The counts from the snorkel surveys are used to calculate an escapement estimate by the Area-Under-the-Curve method. Age compositions were determined by analysis of scales sampled during broodstock collection, test-fishing and in-river sampling. There are two exceptions in the methodology. On the San Juan River partial fence counts are conducted. And in 1998, on the Gold River, a mark-recapture / radio tagging study was also conducted to determine chinook escapement.

Table 7. Streams *(extensive, hatchery extensive)* surveyed since 1995, by StAD, for chinook escapement, in addition to main exploitation *(intensive)* indicator on the Stamp River.

Stream	Stat. Area	Indicator Type	Survey Method
San Juan River	20	Extensive	Fence
Nitinat River	22	Hatchery	Snorkel
Sarita River	23	Extensive	Snorkel
Nahmint River	23	Extensive	Snorkel
Bedwell R / Ursus C	24	Extensive	Snorkel
Moyeha River	24	Extensive	Snorkel
Megin River	24	Extensive	Snorkel
Burman River (PSC)	25	Extensive	Snorkel
Gold River (PSC)	25	Extensive	Snorkel/M-R
Tlupana River	25	Extensive	Snorkel
Conuma R /Canton C	25	Hatchery	Snorkel
Sucwoa River	25	Extensive	Snorkel
Deserted Creek	25	Extensive	Snorkel
Tsowwin River	25	Extensive	Snorkel
Leiner River	25	Extensive	Snorkel
Tahsis River (PSC)	25	Extensive	Snorkel
Zeballos River	25	Extensive	Snorkel
Kaouk River (PSC)	26	Extensive	Snorkel
Artlish River (PSC)	26	Extensive	Snorkel
Tahsish River (PSC)	26	Extensive	Snorkel
Klaskish River	27	Extensive	Snorkel
Marble River (PSC)	27	Extensive	Snorkel

5.2 Escapement Levels in "Extensive" Indicator Systems

In 1998, dry weather during September kept river levels low until early October when the rains began. This meant that the migration of chinook into streams was delayed by two to three weeks in comparison to more typical years. This delay likely resulted in a compression of the in-river residence time compared to past years, which is reflected in the AUC calculations.

As a whole, the PSC aggregate indicators exceeded the rebuilding goal of double the 1979-82 average escapement, for the first time since the start of the base period in 1975 (Figure 2). The Area 25 indicator group exceeded the PSC goal (more than double) for the second year. The Area 26 indicator group also exceeded the PSC goal this year; the first time that this has happened since 1985. The Area 27 indicator (Marble River) had the highest escapement since the start of the base period but still failed to meet PSC goal (only 77% of goal).

In addition to these PSC incdicators, other additional "extensive" escapement indicators along the WCVI also had good chinook returns in 1998. On the south west Vancouver Island most indicator streams showed increased escapements over recent years. For example, the San Juan Enhancement Society operated a fence on the San Juan River (Area 20), primarily for broodstock collection. The 1998 escapement to the San Juan River was the highest since the start of the base period; exceeding the previous maximum by three times. Another example is the Sarita River (Area 23), which had the second highest escapement since the start of the base period (the highest was in 1992). The Nahmint River (also Area 23) had its highest escapement since the start of base period. The exceptions to these observations of high escapements were the Area 24 streams. While the chinook escapement in the Bedwell, Moyeha and Megin rivers was greater than 1997 levels, there was no substantial increase in escapement relative to the 1994-95 period, as exhibited in other areas.

In the north west part of Vancouver Island, the additional "extensive" indicators are situated in close proximity to the PSC indicators. These additional "extensive" indicator streams in the north west Vancouver Island area showed trends similar to the PSC indicators; most systems exhibited high escapements equal to or greater than recent years. There were a few exceptions, including the Klaskish River (Area 27), which had an escapement less than 20% of the base period average.

Age composition of chinook escapements was estimated for a few the "extensive" indicators (Table 8) where samples could be readily collected. Generally, samples were not obtained from "wild" rivers due to the difficulty in obtaining samples (carcasses are eaten by bears, birds, etc. or flushed out of system). Consequently, sampling was generally associated with broodstock collection in the river or estuary. Where possible samples were collected in the estuary, since low river flow levels and high inriver water temperatures delayed migration of mature chinook into the rivers. The resulting age data indicate that the four and five year-olds predominated the returns, while the age two and three components were weak. This corroborates the 1998 Somass system age distribution.

Table 8. Age Composition data from scale analysis.

Stream	Age 21	Age 31	Age 32	Age 41	Age 51	Age 52	Age 61	Total
Nitinat River/ Lake *testfish*	1	43		517	150			711
	0.14%	6.05%	-	72.71%	21.10%	-	-	
Conuma River		28		300	77	1		406
	-	6.90%	-	73.89%	18.97%	0.25%	-	
Sarita River		3		137	19			159
	-	1.89%	-	86.16%	11.95%	-	-	
Nahmint River	4	1		157	42		1	205
	1.95%	0.49%	-	76.59%	20.49%	-	0.49%	
Marble River		23		321	107		2	453
	-	5.08%	-	70.86%	23.62%	-	0.44%	
Total Count	5	98	0	1432	395	1	3	1934
Overall %	0.26%	5.07%	0.00%	74.04%	20.42%	0.05%	0.16%	

In summary, returns to most areas of the WCVI were generally good in 1998. All Statistical Areas showed escapements greater than in 1997. However, the good returns were due to stronger than expected age 4 returns from the 1994 brood year (out to sea in the spring of 1995). There was a general lack of two and three year-old fish in 1998, suggesting poor returns in 1999 throughout the WCVI.

Based on field staff observations, chinook spawning habitat was not fully utilized in 1998, indicating that the current rebuilding goals may be low. An assessment of these escapement goals will be conducted in 2000.

6 Literature cited

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Figure 1. Average annual error for Prod2 and Prod3 forecast models when applied to estimating the terminal run size of Somass chinook into Barkley Sound. Terminal denotes Prod2 model and Total denotes Prod3 model. Error expressed as the deviation from the observed terminal run, 1988 through 1998.

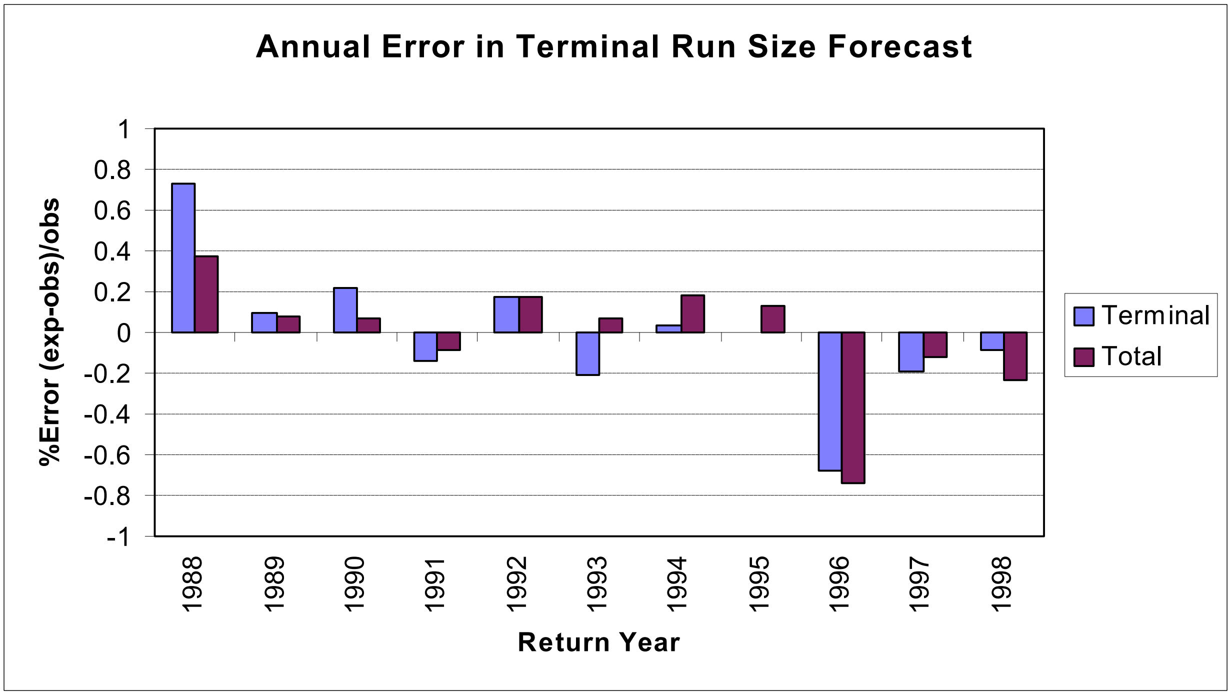
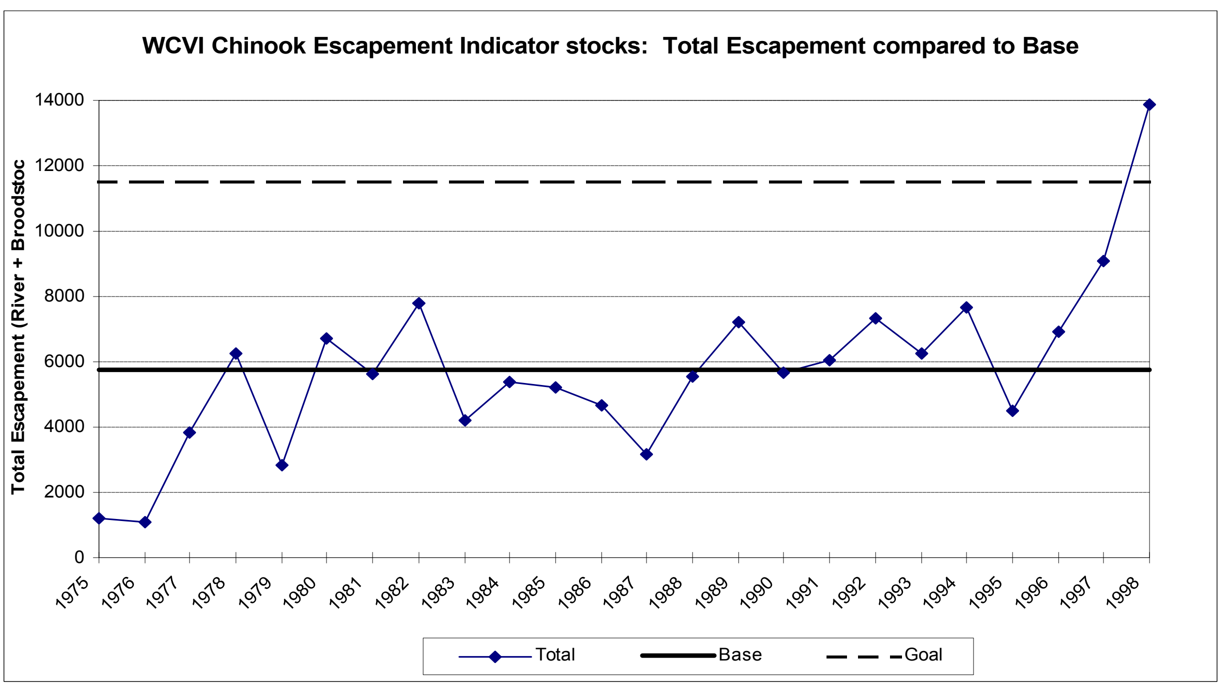


Figure 2. Trend in adult chinook escapement of PSC escapement indicator stocks, 1975 to 1998 where; Total escapement includes natural spawners plus broodstock removals, and "base" means the period 1975 to 1982 average escapement (solid line), and "Goal" indicates the PSC rebuilding goal (double the base period average).



Appendix Table 1. 1998 Somass Chinook Terminal Run, Catch and Escapement

			AGE COMPOSITION							obs
FISHERY	DATE	CATCH	Aged	2	3	4	5	6	Females	MarkInc
ALBERNI INLET CATCH										
TEST FISHERY *proj=4090*		no testfishery in 1998								
COMMERCIAL GN *proj=7500*		no commercial fisheries in 1998								
ALBERNI SPORT *(pr 4060)*	June	43		0.7%	3.0%	90.4%	5.9%	0.0%		
	July	86		0.7%	3.0%	90.4%	5.9%	0.0%		
	August	7,087	135	0.7%	3.0%	90.4%	5.9%	0.0%		3.75%
	September	6,237	342	0.3%	2.9%	90.1%	6.7%	0.0%		3.27%
TOTAL ALBERNI INLET SPORT		**13,453**		**72**	**395**	**12,141**	**845**	**0**		
				0.5%	**2.9%**	**90.2%**	**6.3%**	**0.0%**		
AISPT non Somass expCWT		695		0	6	618	71	0		
AISPT RBT exp CWT		9,223		0	153	8,342	728	0		
AISPT SOMASS only		**12,758**		**72**	**388**	**11,523**	**775**	**0**		
SOMASS NATIVE PSP *(pr 9095)*	31-Aug	2,384	262	0.0%	1.1%	87.4%	11.1%	0.4%		2.99%
	01-Sep	4,426		0.0%	1.1%	87.4%	11.1%	0.4%		3.21%
TOTAL NATIVE PSP FISHERY		**7,172**		**0**	**79**	**6,268**	**796**	**29**		3.18%
				0.0%	**1.1%**	**87.4%**	**11.1%**	**0.4%**		
Native non Somass expCWT		0		0	0	0	0	0		
NATIVE RBT from expCWT		3,620		0	154	3,052	414	0		
NATIVE SOMASS only		**7,172**		**0**	**79**	**6,268**	**796**	**29**		
TOTAL INLET CATCH all stocks		**20,625**		**72**	**474**	**18,409**	**1,642**	**29**		
TOTAL INLET CATCH Somass R. only		**19,930**		**72**	**467**	**17,791**	**1,571**	**29**		
				0.4%	**2.3%**	**89.3%**	**7.9%**	**0.1%**		
TOTAL INLET CATCH rbt expcwt		12,843		0	307	11,394	1,142	0		
TOTAL INLET CATCH natural Somass R only		7,087		72	160	6,397	429	29		
ESCAPEMENT TOTAL all ages		**44,139**		**248**	**1,781**	**39,874**	**2,236**	**0**		
note escapement incl prespawn morts below Stamp Falls				**0.6%**	**4.0%**	**90.3%**	**5.1%**	**0.0%**		
Escapement Total adults only		43,891		-	4.1%	90.8%	5.1%	0.0%		
Total hatchery return based on expCWT		29,885		47	873	28,686	277	-		
Tot inriver female spawners (pre-spawn morts removed)		8,327		-	1	7,473	852	-		
Total inriver eggs (max)		50,918,878								
Total inriver eggs (min)		36,976,804								
		0.72	=spt only							
		0.50	=native catch							
		0.64	=total inlet catch							
		0.68	=total escapement							
RCH/Somass in Alberni Inlet (Aug-Sep comb):		0.66	= BEST ESTIMATE OF RATIO IN BSND (avg of ratio from total inlet catch and total escapement)							
A23B Creel Survey Estimated Total Catch CN		21,349	Jun-Sep, full creel period							
A23B Creel Survey Estimated Total Catch CN		19,505	Aug-Sep only							
RBT total exp cwt (Aug-Sep)		4,249		0	389	3,860	0	0		
				0.0%	9.2%	90.8%	0.0%	0.0%		
A23B SPORT, SOMASS ORIGIN CATCH		**6,431**		**65**	**145**	**5,805**	**389**	**26**		
TOTAL SOMASS CN, AREA 23 SPORT		**19,189**		**138**	**534**	**17,328**	**1,164**	**26**		
E. TOTAL TERMINAL RUN SOMASS ONLY		**70,500**		**386**	**2,394**	**63,470**	**4,196**	**55**		
TOTAL TERMINAL RUN w/o jacks		70,114		**0.5%**	**3.4%**	**90.0%**	**6.0%**	**0.1%**		

Appendix Table 2. Escapement of Somass Chinook, into Robertson Creek Hatchery and Stamp River, 1998

STAMP RIVER CHINOOK ESCAPEMENT

	Adults	Jacks	Total Count
Unadjusted Observed at Stamp	38,103	513	38,616
Adjusted count from tape	39,891	248	40,139
Estimated missed count:	-		
Final adjusted counts (above Stamp	39,891	248	40,139

Jack count based on ratio of jacks to adults for

HATCHERY:

	Total Used	Marked	unMarked	C/S	Released to river Nov
Males (incl jacks):	7,160	269	6,891	1	612
Females:	4,716	141	4,575	1	473
Jacks:	29	1	28	1	
Adjustment factor (J to M):	-	-			
Adult males:	7,131	268	6,863	1	612
Totals:	**11,876**	**410**	**11,466**	1	**1,085**

Totals used in hatchery excludes releases. No sampler error J to M apparent from

CWT recoveries by sex:

			Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	Observed		1	15	245	2	0	263	262
	Estimated		1	15	245	2	0	263	262
	Expanded		46.86	396.31	5117.94	57.43	0	5619	5572
Female	Observed		0	0	125	6	0	131	131
	Estimated		0	0	125	6	0	131	131
	Expanded		0	0	2822.53	182.7	0	3005	3005
Females fr Dam	Observed		0	0	0	0	0	0	0
	Estimated		0	0	0	0	0	0	0
	Expanded		0	0	0	0	0	0	0
TOTAL (swim-in)		Expanded	47	396	7940	240	0	8624	8577
TOTAL (swim-in+GCL)		Expanded	47	396	7940	240	0	8624	8577

Scale Age composition (from biosample fish only, excluding cwt

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	28	48	400	4		480	452
Females	0	3	424	25		452	452
Female/ dam	0	0	0	0		0	0

Pooled Age composition (est cwt + scale by age)/(total sample adults

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl Sample
Males		8.8%	90.3%	0.8%	0.0%	100%	714
Females		0.5%	94.2%	5.3%	0.0%	100%	583
Age composition based on Expanded CWT							
Males	0.8%	7.1%	91.1%	1.0%	0.0%	100.0%	
Females	0.0%	0.0%	93.9%	6.1%	0.0%	100.0%	

TOTAL RETURN TO HATCHERY BY AGE (based on pooled samples):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males (swim-in)	29	629	6442	60	0	7160	7131
Females (swim-in)	0	24	4441	251	0	4716	4716
Total (swim-in)	29	653	10883	311	0	11876	11847
Females from GCL	0	0	0	0	0	0	0
Total (swim-in + GCL)	29	653	10883	311	0	11876	11847
% hatchery (exp cwt) - swim-ins only	*162%*	*61%*	*73%*	*77%*		*73%*	*72%*

0.602 Sex Ratio (Adult Males/Total Adult):
0.004 Ratio of Jacks to Total Males:

INRIVER POPULATION:

Total spawners:	28,263	=Escapement estimate-hatchery, includes
River Adults:	28,044	=Escapement estimate-
In-river Jack estimate (a):	219	=Escapement estimate-
Number of males(incl jacks):	14,613	=total inriver * unweighted pooled sex
Alternate in-river jack est (b):	59	=based on jack/male ratio in
	0.440	=Sex ratio in sample(Adult males / Total
	0.521	= Unweighted males (pooled Hatchery &

	Total popn.	Sample popn.	No. sampled	Sex	C/S Rate
Chosen jack est (a)	219	219	17	J	12.88
Number of adult males:	14,394	13,782	2,758	M	5.00
Number of females:	13,650	13,177	3,507	F	3.76

Table 2. Cont'd. Escapement of Somass Chinook, into Robertson Creek Hatchery and Stamp River, 1998

CWT composition by sex: (cwt for jacks (age 2) are not used in the estimation of total age composition)

	Expansion	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Total Adults
Males	Observed	-	6	83	1	-	90	90
	Estimated	0	30	415	5	-	450	450
	Expanded	0	390	8398	110	-	8,897	8,897
Female	Observed	0	0	98	9	-	107	107
	Estimated	0	0	368	34	-	402	402
	Expanded	0	0	9031	974	-	10,004	10,004
Total	Expanded	-	390	17,429	1,084		18,902	18,902

Scale Age composition (number at age in sample):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total Adults	Ttl Jacks
Males	15	29	366	11		406	15
Females	0	0	336	48		384	0

Pooled Age composition (est cwt + scale by age)/(total sample adults only):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total
Males	100.0%	6.9%	91.2%	1.9%	0.0%	100.0%
Females	0.0%	0.0%	89.6%	10.4%	0.0%	100.0%

In-River return of 'sample population' by age (based on pooled samples, include jack estimate directly):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	219	950	12574	258	0	14001	13782
Females	0	0	11805	1372	0	13177	13177
Total	219	950	24380	1629	0	27178	26959
% hatchery (exp cwt)	*0%*	*41%*	*71%*	*0%*		*66%*	*66%*

TOTAL SPAWNING ESCAPEMENT TO STAMP RIVER (in-river return minus river captures, based on pooled scale and CWT ages)

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	219	1004	13127	263	0	14613	14394
Females	0	2	12251	1397	0	13650	13650
Total	219	1006	25378	1659	0	28263	28044
Prespawn Mortality Females only (max)	39%	39%	39%	39%	39%		
Prespawn Mortality Females only (min)	16%	16%	16%	16%	16%		
Prespawn Mortality Females only (max)	0	1	4778	545	0	5324	
Prespawn Mortality Females only (min)	0	0	1960	223	0	2184	
Inriver female spawners (max)	0	2	10291	1173	0	11466	
Inriver female spawners (min)	0	1	7473	852	0	8327	
Fecundity		4000	4400	4800	5200		
Total Egg Deposition (max)		**8,178**	**45,279,184**	**5,631,516**	**0**	**50,918,878**	
Total Egg Deposition (min)		**5,939**	**32,881,312**	**4,089,553**	**0**	**36,976,804**	

Prespawn Mortalities On Route (below Stamp Falls):

Estimate from snorkel and dive surveys. Applied the 'pooled' In-river sex and age compositions to prespawn mortalities in the Lower River (below Stamp Falls):

On Route - below S. Falls: Prespawn Mort. Est. 4,000

Age composition (from scales and cwt's):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Total Adults
Males	0	121	1607	33	0	1761	1761
Females	0	0	2006	233	0	2,239	2239
Total	0	121	3613	266	0	4000	4000

TOTAL ESCAPEMENT RUN TO STAMP RIVER ABOVE STAMP FALLS (spawning escapement + prespawn morts + hatchery remo

		Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	-	248	1,633	19,569	323	-	21,773	21,525
Females	-	-	27	16,692	1,647	-	18,366	18,366
Total	-	248	1,660	36,261	1,970	-	40,139	39,891
Total expanded CWT		47	786	25,369	240	-	26,442	26,395
% hatchery (exp cwt)		*19%*	*49%*	*72%*	*12%*		*68%*	

TOTAL ESCAPEMENT RUN TO STAMP RIVER (spawning escapement + prespawn mortalities + hatchery removals).

		Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	-	248	1,755	21,176	356	-	23,534	23,286
Females	-	-	27	18,698	1,881	-	20,605	20,605
Total	-	248	1,781	39,874	2,236	-	44,139	43,891

notes:

total fishway count includes swim count Sep 2, fishway sep 2 - nov 10

fishway counts were adjusted for observer error

**total run into hatchery is that killed for broodstock,surplus, etc....all sampled for marks...all others released

assume released chinook are part of river number, but never part of any sample.

***% hatchery (exp cwt) No attempt at recoveries from Pre-spawn morts below S. Falls so apply estimate from above S. Falls

Appendix 3. Total Adult Chinook Escapement (river + brood) estimates for selected WCVI systems (no Jack males)
(Table entries 'ni' = stream not investigated in that year, or 'no' = indicates that no chinook were observed in that year)

AREA RIVER	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
A. PSC Indicator stocks.													
25 Tahsis River	60	20	125	500	300	1400	1400	500	380	525	771	722	587
25 Burman River	400	100	400	700	1100	2500	2000	1750	2200	594	724	2354	3205
25 Gold River	1900	600	1000	1000	2000	1000	2500	1700	3600	805	902	1874	2229
26 Kaouk River	100	100	65	30	10	20	20	20	150	266	219	558	824
26 Artlish River	100	100	70	40	50	20	10	10	100	99	53	402	300
26 Tahsish River	1000	500	400	450	200	120	600	250	250	600	288	523	1430
27 Marble River	1100	1750	3500	4500	2000	1000	800	2000	1000	1626	3971	2638	5297
% Marble River in Index:	23.6%	55.2%	62.9%	62.3%	35.3%	16.5%	10.9%	32.1%	13.0%	36.0%	57.3%	29.1%	38.2%
B. Other systems: wild or hatchery supplemented. Intensively surveyed since in 1994 or 1995 but less consistently before that time.													
25 Leiner River	190	125	336	500	450	300	445	585	300	412	715	516	380
24 Bedwell/Ursus	10	8	10	70	ni	ni	ni	377	691	291	528	275	306
24 Moyeha River	ni	no	no	80	ni	ni	ni	250	420	89	243	84	155
24 Megin River	30	25	30	26	ni	10	150	436	841	323	164	266	370
23 Nahmint River	287	400	97	279	596	165	135	158	438	212	246	242	784

Sums for Sections A & B:

	Spawning Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
A.	PSC indicators	4660	3170	5560	7220	5660	6060	7330	6230	7680	4515	6928	9071	13872
B.	Other systems.	517	558	473	955	1046	475	730	1806	2690	1327	1896	1383	1995

Systems with major hatcheries

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
22 Nitinat River	8000	2500	21047	17000	19000	12000	30000	25000	11000	10538	29809	34482	34854
23 Somass River	36289	53478	66959	63043	112061	114416	141060	96254	57678	27801	28500	32121	43891
25 Conuma River	210	200	3000	7000	10700	15000	22000	11500	20000	23071	19422	20813	26311

Appendix 4. Coded-wire tag groups utilized in the cohort analyses for this analysis. The format of this listing is by Brood Year followed by the 6-digit tag code. Tag codes are selected to represent "production" and "both production and experimental" releases from the facility and are reviewed by Stock Assessment Division and the Salmonid Enhancement Program.

@83 (Brood year)
022662
022663
022708
022753
082247
082248
@84
023131
023132
023133
023134
023135
023136
023142
023143
023144
023145
023151
023203
023204
023206
023208
023304
@85
023734
023735
023736
023737
023738
023739
023740
023741
@86
024256
024257
024361
024362
024363
024401
@87
024311
024802
024809
024810
024951
024952
024958
024959
@87(continued)
024960
024961
025326
025327
025328
025329
@88
025014
025836
025837
025838
025839
026055
026056
026057
@89
020645
020646
020950
020949
020948
020648
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021549
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180620
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