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Review of 1999 Terminal Run of Somass (Stamp) River Chinook Salmon and 1999 Escapement to WCVI Extensively Surveyed Indicators, and Forecast for 2000

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Abstract

The detailed assessments and abundance forecasts of the Robertson Creek Hatchery (RCH) and Stamp River chinook are undertaken annually for management of ocean and terminal fisheries, and as an indicator of the expected returns to the naturally spawning chinook populations along the west coast of Vancouver Island (WCVI). Forecasts presented in this working paper indicate a conservation concern developing for naturally spawning chinook populations along the WCVI during the next few years. The minimum escapement goal established for the Stamp/RCH chinook stock will not be met in 2000 and total terminal return for this stock is projected to decline by 66% relative to 1999. If this decline is assumed for the naturally spawning stocks along the WCVI, the numbers of females expected to spawn naturally in 2000 will vary from as low as 30 females to over a couple of hundred females in each river system.

<u>1999 Terminal return of the WCVI chinook:</u>

The 1999 terminal return of chinook to the Stamp River/RCH indicator stock was estimated to be 30,500 (a 57% decline from the 1998 return) (Table 4). Age-5 chinook comprised the majority (69%) of the spawning stock and returns of age-3 and age-4 chinook were much lower than average. The age 3 return is production from the 1996 brood, which was the lowest escapement on record.

Returns to another 22 WCVI streams that were monitored for chinook spawning escapements did not indicate a proportional reduction as large as the indicator stock but the age compositions were generally very similar. In all extensively surveyed systems along the WCVI (excluding the two rivers, Nitinat and Conuma, with major hatcheries), the 1999 total escapement declined 28% from 1998 levels. Escapements to the Nitinat and Conuma rivers each declined by about 40% from 1998. However, there was significant variation between systems with two rivers (San Juan River and Sarita River in southwest Vancouver Island) indicating greater declines than for the Stamp River/RCH indicator stock. On average, the age-5 chinook comprised 64% of the spawning populations along the WCVI, and age-3 and age-4 components were weak. The overall age composition was very similar to that in the Stamp River/RCH terminal run.

<u>Forecast for the 2000 terminal return of the WCVI chinook:</u>

The forecasting methods applied have been reviewed and accepted previously by PSARC. However, for the first time, the method could not be applied to one age-class since no coded-wire tags were recovered from age-2 chinook. Consequently, the forecast of age-3 chinook in 2000 is based on the lowest cohort size for age-3 chinook observed from past brood years (cohort sizes for 1983 and 1996 broods were about 4000 chinook).

For 2000, the forecasted total return of Stamp River/RCH chinook to the terminal area of Barkley Sound and Alberni Inlet is estimated to be 10,000 based on averaging the Prod2[1] forecast of 12,000 and the Prod3[2] forecast of 7,800. The mean absolute percent error in the average forecast (1985-1999 returns) is 10%. The age structure of the 2000 return is projected to be: 13%

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[1] 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.
[2] 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.

Age 3, 52% Age 4, and 35% Age 5; with an expected sex ratio of 50% females (note that the forecast of Age 3 is very uncertain). At this time, the forecast only assumes fishing mortality in South East Alaska (SEAK). Harvest rate factors in SEAK were based on the Pacific Salmon Treaty agreements and we initially used a harvest rate scalar of 0.5 in SEAK troll fishery. The remaining cohort is identified as the expected terminal run assuming no fishing mortality on this stock in Canada.

At this level of terminal run to the Stamp River/RCH, the indicator stock will not achieve the minimum target escapement goal established by PSARC in 1995. The forecast represents a further two-third (66%) reduction in terminal abundance relative to 1999 returns and would be the smallest return since 1985 (Fig. 7), when the indicator stock program began. However, given the expected sex ratio, the expected number of eggs available will be the fourth worst since 1985 (Table 5).

A slightly more conservative terminal run is predicted if the forecast is expressed as a cumulative probability distribution as previously requested by PSARC. Based on the annual deviations from forecasts observed between 1988 and 1999, the 50% value of the cumulative distribution is 9000 chinook in the terminal run and the 50% confidence interval is 8200 to 9800 chinook (Fig. 8). However, given that this distribution is based on only 12 years of observations, the authors recommend continuing with past methods and applying the average forecast model that predicts 10036 chinook returning to the terminal area of Barkley Sound.

The more serious concern for conservation is the expected run size to the naturally spawning chinook populations along the WCVI. While the relative decline from 1998 to 1999 was not as large in many of these populations, relative to the Stamp River/RCH stock, we are unable to make specific forecasts for these natural populations. Applying the expected decline for the Stamp River/RCH indicator stock to these naturally spawning populations provides a conservative expectation of their returns in 2000 (Table 6).

Returns to most of these streams in 2000 are not likely to constitute a serious conservation concern with the possible exception of returns to the Area 24 streams. However, these are returns projected for 2000 only and do not indicate the declines expected in future years. Marine survival rates for the 1995 through 1997 brood years from RCH indicate that production from WCVI populations is expected to be poor for a few years (likely through 2002).

Résumé

Chaque année, le saumon quinnat des piscicultures de Robertson Creek («RCH») et de Stamp River fait l'objet d'évaluations et de prévisions de l'abondance détaillées, utilisées dans la gestion des pêches en mer et en estuaire, mais aussi comme indices des remontes des populations sauvages le long de la côte ouest de l'île de Vancouver («WCVI»). Les prévisions faites dans le présent document indiquent que la conservation de ces dernières populations sera une source de préoccupation au cours des prochaines années. L'objectif minimal d'échappée du quinnat de Robertson Creek et de Stamp River ne sera pas satisfait en 2000 et, d'après les prévisions, la remonte totale de ce stock en estuaire chutera de 66 % par rapport à 1999. Si les stocks sauvages de la côte ouest de l'île de Vancouver affichent la même baisse, le nombre prévu de femelles qui pondra en 2000 ira d'un creux de 30 à quelque 200 dans chaque réseau fluvial.

Retour en estuaire du quinnat de la côte ouest de l'île de Vancouver en 1999 :
Pour 1999, on avait prévu un retour en estuaire de 30 500 quinnats du stock indicateur de Stamp River et de Robertson Creek (soit une baisse de 57 % par rapport au retour de 1998) (tableau 4). Le quinnat de 5 ans constituait la plus grande partie (69 %) du stock reproducteur et les retours de quinnats de 3 et de 4 ans étaient nettement plus faibles que la moyenne. Les quinnats amontants de 3 ans sont issus de l'année de génération 1996, qui était la plus faible échappée enregistrée.

Les retours à 22 autres cours d'eau de la côte ouest de l'île de Vancouver où l'échappée a été contrôlée n'indiquent pas une réduction proportionnelle aussi marquée que dans le cas du stock indicateur, bien que la composition selon l'âge soit généralement très semblable. Dans tous les réseaux fluviaux de la côte ouest de l'île de Vancouver faisant l'objet d'un relevé détaillé (à l'exclusion des rivières Nitinat et Conuma, où sont situées de grandes piscicultures), l'échappée totale en 1999 a chuté de 28 % par rapport aux niveaux de 1998. Les échappées des rivières Nitinat et Conuma ont aussi chacune diminué d'environ 40 % par rapport à 1998. Les réseaux fluviaux ont toutefois marqué une forte variation, deux rivières (les rivières San Juan et Sarita du sud-ouest de l'île de Vancouver) affichant des déclins plus marqués par rapport au stock indicateur Stamp - Robertson. En moyenne, le quinnat de 5 ans constituait 64 % des populations de reproducteurs de la côte ouest de l'île de Vancouver, tandis que les individus de 3 et de 4 ans étaient peu abondants. La composition générale selon l'âge était très semblable à celle de la remonte en estuaire du quinnat Stamp - Robertson.

Prévision du retour en estuaire du quinnat de la côte ouest de l'île de Vancouver en 2000 :
Le PSARC a déjà passé en revue et accepté la méthode de prévision appliquée. Toutefois, pour la première fois, celle-ci n'a pu être appliquée à l'une des classes d'âge étant donné qu'aucune étiquette métallique codée n'a été récupérée chez le quinnat de 2 ans. Par conséquent, la prévision pour 2000 du nombre de quinnats de 3 ans est fondée sur la plus faible taille observée de la cohorte de quinnats de 3 ans issue des années de génération précédentes (la taille des cohortes issues années de génération 1983 et 1996 se situe à environ 4 000 quinnats).

Pour 2000, on prévoit une remonte totale estimative de 10 000 quinnats de Stamp River et de Robertson Creek à l'estuaire de Barkley Sound et de Alberni Inlet d'après la moyenne des prévisions respectives pour les Prod2[3] et 3[4] de 12 000 et 7 800 quinnats. L'erreur moyenne absolue en pourcentage de la prévision moyenne (retours 1985-1999) se situe à 10 %. Pour 2000, on prévoit un retour composé à 50 % de femelles et comportant 13 %, 52 % et 35 % d'individus âgés respectivement de 3, 4 et 5 ans (notez que la prévision pour l'âge 3 est très incertaine). À ce moment, la prévision suppose qu'il n'y a mortalité par pêche que dans le sud-est de l'Alaska («SEAK»). Les taux de capture dans cette région sont fondés sur les ententes conclues dans le cadre

[3] Le modèle de régression fait appel à une remonte totale en estuaire de quinnats appartenant à une classe d'âge plus jeune (variable indépendante) pour prédire la production totale (la cohorte survivant en mer) de quinnats appartenant à la (aux) classe(s) d'âge suivante(s) issue(s) de la même année de génération.
[4] Le modèle de régression fait appel à la production totale estimative (la somme de la mortalité totale par pêche et de l'échappée) de quinnats d'une classe d'âge donnée pour prédire la production totale des classes d'âge suivantes (c.-à-d., la cohorte survivante) issues de la même année de génération.

du Traité sur le saumon du Pacifique. Nous avons utilisé au départ un taux de capture scalaire aux lignes traînantes de 0,5. La cohorte restante est considérée comme la remonte attendue en estuaire si ce stock ne subit aucune mortalité par pêche au Canada.

À ce niveau de retour à l'estuaire de Stamp River et de Robertson Creek, le stock indicateur n'atteindra pas l'objectif minimal d'échappée établi par le PSARC en 1995. La prévision représente une réduction additionnelle de 66 % de l'abondance en estuaire par rapport aux retours en 1999; elle constituerait le retour le moins abondant depuis 1985 (figure 7), lorsque le programme des stocks indicateurs a débuté. Toutefois, étant donné la proportion des sexes probable, la ponte prévue sera la quatrième plus mauvaise depuis 1985 (tableau 5).

On prévoit une remonte en estuaire légèrement plus modeste lorsque la prévision est exprimée sous forme d'une distribution de probabilité cumulative, comme l'a déjà demandé le PSARC. D'après les écarts annuels des prévisions observés entre 1988 et 1999, la remonte en estuaire au niveau de distribution de 50 % se chiffre à 9 000 quinnats, tandis que l'intervalle de confiance à 50 % va de 8 200 à 9 800 quinnats (figure 8). Mais comme cette distribution n'est basée que sur des observations recueillies sur une période de 12 ans, les auteurs recommandent que l'on continue d'utiliser les méthodes précédentes et que l'on applique le modèle de la prévision moyenne, qui prévoit le retour de 10 036 quinnats à l'estuaire de Barkley Sound.

Au plan de la conservation, c'est la taille prévue de la remonte des populations sauvages de quinnats de la côte ouest de l'île de Vancouver qui préoccupe le plus. Bien que le déclin relatif observé entre 1998 et 1999 ne soit pas aussi marqué chez beaucoup de ces populations par rapport au stock Stamp - Robertson, nous ne sommes pas en mesure de faire des prévisions spécifiques à ces populations naturelles. Si l'on applique le déclin prévu du stock indicateur Stamp - Robertson à ces populations sauvages, on obtient une estimation prudente de leurs remontes en 2000 (tableau 6).

Il est peu probable que les remontes dans la plupart de ces cours d'eau en 2000 préoccupent beaucoup au plan de la conservation, sauf peut-être les remontes dans les cours d'eau de la zone 24. Les remontes prévues ne concernent toutefois que 2000 et ne sont pas des indices des déclins attendus dans les années à venir. Les taux de survie en mer des années de génération 1995 à 1997 issues de la pisciculture de Robertson Creek indiquent que l'on peut s'attendre à ce que la production des populations de la côte ouest de l'île de Vancouver soit médiocre pendant quelques années (probablement jusqu'en 2002).

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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 1999 and a forecast of the 2000 return. Historic data are not repeated but were 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.

Analyses of coded-wire tag (CWT) data 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 southeast Alaska fisheries (SEAK). In one year of high productivity, production of tagged chinook salmon from RCH alone, including total terminal run plus ocean catch, exceeded 500,000 chinook (1991 return year). This catch is based on expanded CWT data but does not account for incidental mortality in ocean fisheries, or 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 (WCVI). 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 (to guide chinook rebuilding) 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 resulting from an unprecedented "El Nino" event in the 1992-1995 period required formulation of an interim minimum escapement level used for management in 1996 through 1999. 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 stock for exploitation rate and distribution pattern of WCVI chinook populations. 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 1999 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 survey, 2,307 interviews (15% of the fishing effort) were conducted in Alberni Inlet and approximately 1,419 interviews (6 % of the fishing effort) were conducted in Barkley Sound. Fishing effort was surveyed in all sub-areas approximately twice per week or more.

All chinook were examined to determine the true mark incidence in the fishery. In Alberni Inlet 724 and 500 chinook were observed in August and September respectively. In Barkley Sound, 1231 and 1746 chinook were observed in August and September respectively. Due to a discrepancy in methods, the observations from September in Alberni Inlet were not used; instead the sample and number of marks observed in the native gill net fishery during the same period was used as the mark rate. A total of 415 chinook observed during the interviews were sampled for scales and length; and otoliths were removed from 100 of these for examination of hatchery contribution based on thermal marking.

The total chinook catch in Alberni Inlet was estimated to be 7585 chinook of all origins from approximately 15663 boat trips (Alberni Inlet includes waters out as far as Pocahontas Point). An estimated 230 chinook originated from other enhancement (expanded CWT). As a result, the total catch of Somass River chinook in Alberni Inlet is estimated to be 7355 fish (see Appendix Table 1). Based on expanded CWT recoveries, 3243 chinook were of RCH origin. The remaining 4112 chinook were estimated to originate from Stamp River natural spawners.

The terminal run calculation includes all Somass system chinook caught in the sport fishery in DFO Statistical Areas 123 and 23 (Barkley Sound and Alberni Inlet). During June through September in Barkley Sound the total catch of chinook was estimated to be 40361. During the migration period of Somass River chinook (August and September), the total chinook catch in Barkley Sound was 25634 from approximately 36356 boat trips. The catch of Somass River chinook was estimated as the expanded CWT in Barkley Sound divided by the 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 2049 chinook, a much smaller portion of the catch than in past years.

The total catch of Somass River chinook in Area 23 sport fisheries was estimated to be 9404 fish.

2.2 Native Fishery Monitoring

Under an agreement between DFO and the local First Nations, Somass Food and Sales Fisheries (SFSF) 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. In addition to small catches for food, sales fisheries were conducted September 7 and 16. Landing slips were required in the SFSF fishery and the total catch determined as the total from all landing slips collected. This estimate was also reviewed from sales information provided by buyers. The total catch in 1999 was 3591 chinook.

Biological sampling was conducted on a portion of the catch as it was unloaded at the processing plant. In all, 1618 chinook (45% of the total catch) were sampled for mark incidence; and scales, sex, otoliths and length were taken from 100 chinook.

2.3 Stamp Falls Fishway Observations of Total Escapement

Monitoring of salmonid migration through Stamp Falls fishway was conducted from September 3 until November 5, 1999. A snorkel survey was conducted above Stamp Falls on September 3 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 3 to 24 from approximately 0.5 hour before sunrise to 0.5 hour after sunset. From September 25 to October 31, observations were reduced to 12 hours/day and then to 11 hours/day from Nov 1 to 5. Night time migration was videotaped from September 9 until October 31 except for September 28 and October 27 to 30 when technical difficulties and/or high flows prevented taping.

Favourable conditions during the summer resulted in early migration of sockeye into Great Central Lake with very low fall migration. Coho escapement of approximately 46000 was down significantly from the record count in 1998 but was still one of the highest on record. Moderate flows and water temperatures during the fall of 1999 had no noticeable impact upon the migration of any species through Stamp Falls. The overall effect of the above conditions was a less congested fishway and viewing box than in 1998 and resulted in excellent conditions for the observers.

The setup was similar to that used in 1998. A video camera was mounted vertically above the counting tunnel and above the water. 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 reflection of light from above. Underwater lights were placed in the box to provide light for the camera and observers. Lines were marked on the side and bottom of the fishway to aid the observers in determination of jack or adult for each species.

Significant modifications were made to the viewing box itself to optimize the mirror size and ensure an image free from obstructions. The modifications worked very well and the images obtained were of excellent quality. No daytime observations were lost due to high flow or poor visibility.

Day time Procedures

Day time 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 and maturity (adult or jack) were recorded for each fish as they passed by, along with any comments. Any chinook of 59cm or less 'total' length were considered to be jacks and were 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.

Night time Procedures

In recent years the fishway has been left open at night to allow free migration of chinook to avoid exerting unnecessary stresses on the fish. Migration during the night time period was thought to be minimal and of little significance to the overall escapement. In 1998 observations were conducted for 24 hours/day at Stamp Falls. These observations indicated that a significant proportion of the chinook run can migrate through Stamp Falls at night. Funding was not available to observe migration for 24 hours/day in 1999 so night time migration was videotaped, from September 9 to October 31, for subsequent review. A video camera, Super VHS time lapse VCR and lighting operated at night off a bank of batteries and through an inverter. The batteries were re-charged during the day from the generator being used to operate the daytime equipment. Each nights entire migration was recorded by setting the VCR to record up to 12 hours on one videotape. Technical difficulties resulted in the tape operating for only six hours on four nights and in no recording on one other night. Night time migration accounted for 20% of the chinook adult escapement and 9% of the jacks/jimmies. The observed night time migration may not be indicative of natural night time migration as it may be influenced by the lighting used in the fishway.

Verifications

Day time observer error was estimated from verification of 96 randomly chosen hours of tape. An experienced observer from the Stamp Falls fishway crew conducted the verifications. Verifications were entered into the same MSAccess database as for the 'real time' events. Where there were any difficulties in determining either the species or the number of fish passing through the observation box the videotape was slowed, paused or replayed. Results from verifications were considered to be a true reflection of the daytime migration.

Linear regression was used to compare the verification with the 'real time' observations. A highly significant relationship between "true" and "observed" was found for chinook adults. In contrast, a very poor relationship was determined for chinook jacks. The highly significant relationship for chinook adults was probably due to the experience of the field crew and because chinook were more easily distinguished from coho than in past years because of their large average size (due to an older age composition). Jacks have always been poorly observed due to difficulty in determining their size (compared against reference lines marked on the tunnel) and difficulty in species identification – sometimes being confused with coho. Therefore, an unweighted average of the following was used to determine chinook jack numbers;

i. the ratio of chinook jacks to chinook adults in the verifications applied to the adjusted adult return.
ii. the ratio of verified chinook jacks to real time chinook jacks applied to the real time chinook jack count.

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

Chinook adults: $CNAD_{adj} = CNAD_{rt} / 0.9841$ $r^2 = 0.996$, d.f. = 95

Chinook 'jacks': $CNJK_{adj} = (((\Sigma CNJK_v / \Sigma CNAD_v) * CNAD_{adj}) + ((\Sigma CNJK_v / \Sigma CNJK_{rtv}) * \Sigma CNJK_{rt}))/2$

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

$CNAD_{rt}$ = real time chinook adult count.

$CNJK_{adj}$ = adjusted chinook jack/jimmies count.

$\Sigma CNJK_v$ = sum of verified chinook jacks/jimmies.

$\Sigma CNAD_v$ = sum of verified chinook adults.

$\Sigma CNJK_{rtv}$ = sum of real time chinook jacks/jimmies for all verification periods.

$\Sigma CNJK_{rt}$ = sum of real time chinook jacks/jimmies.

Night time Video Review

The same experienced observer who conducted the daytime verifications reviewed the night time videotapes. Every second videotape was reviewed and data was entered into the same MSAccess database as for the 'real time' events. Because the reviewed tapes were evenly distributed (every other one reviewed) through the main portion of the run the total observations were doubled and an adjustment made for the periods when there was no taping.

The nighttime counts were determined as follows:

$$CNAD_n = \Sigma((CNAD_{nr})*2) + (5.42/100)*\Sigma((CNAD_{nr})*2)$$

$$CNJK_n = \Sigma((CNJK_{nr})*2) + (3.72/100)*\Sigma((CNJK_{nr})*2)$$

Where $CNAD_n$ = chinook night time adults.

$\Sigma CNAD_{nr}$ = sum of chinook nightime adults reviewed on video.

5.42 = % of total daytime chinook adults migrating when corresponding nighttime video is not available.

$CNJK_n$ = chinook nighttime jacks/jimmies.

$\Sigma CNJK_{nr}$ = sum of chinook nightime jacks/jimmies reviewed on video.

3.72 = % of total daytime chinook jacks/jimmies migrating when corresponding nighttime video is not available.

1997 Brood Returns

The 1999 escapement included a significant return of small chinook returning after only a few months in the sea (named 'jimmies'). These chinook were released by RCH as yearlings (due to fears of high smolt predation in spring 1998). These fish were considerably smaller than the typical 'jack' which is the same total age but has spent one extra year in the ocean. They were therefore easy to distinguish during verifications. The verifications showed that 89% of the fish originally counted as 'jacks' were in fact 'jimmies'. Estimates of 'jimmies' from both deadpitch and hatchery scale sampling confirmed this, indicating 83% and 85% of the 1997 brood fish were 'jimmies'. The result from $CNJK_{adj}$ was therefore reduced by 89% (see 'Estimate of Escapement'). Similarly, night time videos indicated that 81% of the 1997 brood fish were 'jimmies'.

Estimate of Escapement

The total escapement to Stamp River was calculated as:

$$CNAD_{esc} = CNAD_{adj} + CNAD_n + CNAD_{ssadj}$$

$$CNJK_{esc} = (CNJK_{adj} - 0.89(CNJK_{adj})) + (CNJK_n - 0.81(CNJK_n)) + CNJK_{ssadj}$$

Where $CNAD_{esc}$ = chinook adult escapement.

$CNJK_{esc}$ = chinook jack escapement

$CNAD_{ssadj}$ = chinook adult swim survey adjusted for observer error.

$CNJK_{ssadj}$ = chinook jack swim survey adjusted for observer error.

A minor component of the chinook return is not accounted for as a result of bypass of the fishway via the falls. Bypass is difficult to quantify. Some salmon, mostly coho but some chinook, were observed part way up Stamp Falls, well above the entrance to the fishway. However, no fish were observed successfully making it past the more difficult upper portion of the falls in 1999. It is assumed that fish making it part way up the falls eventually drop back down and enter the fishway.

2.4 Sampling at Robertson Creek Hatchery

In 1999, 4057 chinook entered RCH, including 2531 females (62% of the total). All fish entering the hatchery were counted and recorded by sex. Jacks were distinguished from larger chinook based on a length of 50-cm post orbital hypural (POH) length.

Ripe females were spawned immediately after brailing. Green females were released into a holding pond until mature enough for spawning. All spawned females and pre-spawn mortalities were checked for adipose fin clips. Males were kept in a separate holding pond and were randomly chosen from this 'pool' of fish for spawning. After spawning, the males were returned to the same common 'pool' from which they could again be randomly chosen during subsequent spawning operations. The only males sampled for CWT's (adipose fin clipped marks) were pre-spawn mortalities recovered from the holding pond. Once the egg target had been obtained at the hatchery all remaining males and females were released (without being checked for missing adipose fins) back into the Stamp River to enhance the naturally spawning population. The age composition of the total return to the hatchery was based on two independent samples for each sex;

i. ages from CWT's of adipose clipped fish.

ii. 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.

Great Central Lake Dam

The early returns of chinook to Robertson Creek hatchery appeared to be very poor in 1999. To ensure that the hatchery requirements were met, chinook were captured using a trap at Great Central Lake Dam. Ripe fish were spawned immediately and green fish were transported back to the hatchery for holding. From September 29 to October 19, 89 females, 6 males and 7 jacks/jimmies were retained while 0 females, 52 males and 46 jacks/jimmies were released. Biological data (including scales, otoliths, POH lengths and adipose fin clip data) were collected from spawned fish.

2.5 Sampling on Spawning Grounds

Sampling of carcasses in the Stamp River was conducted from October 12 through November 2. Water levels were moderate and no time was lost due to high flows/dangerous conditions. Objectives included biological sampling (including scales, otoliths, egg retention level and some fork lengths) of about 500 chinook per sex and all jacks/jimmies. All carcasses encountered were sampled for adipose fin clips (AFC) and POH length as well as sex. Samples were collected using a carcass net and by searching for and gaffing carcasses along river banks/bars using a jet boat. Tails were severed from all sampled fish.

In 1999, 2782 chinook (21% of the river population) were sampled for AFC, with 78 recoveries. Complete biological samples were taken from 324 adult males, 10 jacks, 49 jimmies and 380 females while length and sex was taken from all samples. Sample data are summarized in Appendix Table 2.

Total in-river escapement was determined by subtraction of the hatchery count from the adjusted fishway count. A component was added to account for the releases from the hatchery back into the river. Adult males and jacks are usually underrepresented in the deadpitch sample due to their post spawning behaviour. The in-river sex ratio was therefore estimated as the unweighted average of the hatchery and deadpitch sex ratios.

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

In-river count	= total escapement - total hatchery count
Total river males (TRM)	= in-river count x unweighted sex ratio
River females	= in-river count - TRM
River jacks	= total escapement - total hatchery count
Adult river males	= TRM - river jacks

The same criteria were used to determine age composition by sex 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/Stamp River and RCH chinook in native, sport, and commercial fisheries, plus spawning escapement to the RCH and Stamp River.

Table 1a. Summary of 1999 terminal run of Somass River chinook.

Fishery	# Age 2	# Age 3	# Age 4	# Age 5	# Age 6	Total
Alberni Inlet Sport	115	757	1,592	4,892	0	7,355
Somass Native	0	122	898	2,571	0	3,591
Barkley Sound Sport	0	362	362	1,326	0	2,049
Hatchery Returns[1]	25	49	357	1,722	9	2,162
River Escapement[2]	63	865	3,797	10,526	124	15,375
Total Terminal Run	203	2,155	7,005	21,037	133	30,532

[1] Includes captures from Great Central Lake Dam but excludes hatchery releases.
[2] Stamp River only, includes prespawn mortalities and hatchery releases.

Overall, the terminal run was 78% percent of the 39000 forecast. The age 4 component of the total terminal run was 163% of the forecast while the age 3 return was just 43% of the forecast and the age 5's were 71% of the expected return. Female spawners in the river totalled approximately 8400 which produced a deposition in the river of almost 40 million eggs. Another 1851 females swam into the hatchery and were utilized there. Based on expanded CWT data, the estimated proportion of hatchery origin chinook in the total terminal run was about 60%, and about 68% of the chinook escapement into 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	0	590	2,653	0	3,243
Somass Native	0	0	436	1,601	0	2,037
Barkley Sound Sport	0	210	210	771	0	1,191
Hatchery	0	307	711	3,063	25	4,105
River	0	143	2,263	5,356	0	7,762
Total Terminal Hatchery	0	660	4,210	13,444	25	18,338

3 Analytical Framework

3.1 Cohort Analyses

Cohort analysis is conducted using 'estimated' CWT recoveries to determine survival rates and exploitation patterns for RCH chinook. The incorporation of in-river tag recoveries provides estimates of the true total exploitation rates. 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 (99)-2). 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 (99)-2.

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 for total production from selected 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. Tag codes used are listed in Appendix Table 5.

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., 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 examine response in terminal runs to changes in ocean harvest rates by fishery and age. Based on forecasted ocean abundance (section 3.3) and exploitation patterns through the current year (year i), the model estimates terminal runs expected in year i+1 (and year i+2) based on changes to harvest rates anticipated in ocean fisheries.

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 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. Cohorts may be harvested in ocean and terminal fisheries, and/or allowed to become spawners. 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. These values were 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 X96-01, for years 1988 through 1995. Including the information through 1999 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. A terminal return is estimated for each predicted value by the same method as outlined in the spreadsheet. The predicted terminal return is compared to the terminal return actually observed for that year. The error is expressed as a mean absolute percent error (MAPE) for each model or the average of the two models.

In this assessment, the forecast errors (annual deviations) are used to estimate the probability distribution for the predicted terminal run in 2000. The distribution is only based on twelve data points through 1999 but does present the 2000 forecast within a probabilistic framework. Only the average of the two forecast models is used in developing this distribution.

4 Results and Forecast for 1999

4.1 Cohort Analyses

Cohort analyses for the 1983 through 1997 brood releases from RCH were completed using the total escapement of coded-wire tags to the hatchery and the natural spawning grounds in the upper Stamp River. Note that the returns from the latter 3 broods are incomplete through 1999, so surviving cohorts are estimated using average maturation rates from the completed brood returns.

The cohort analysis provides insight into the annual exploitation and survival of the RCH chinook, including:

- Recoveries from the 1992 brood year are very limited (estimated number of recoveries = 10) and the cohort analysis is not reliable.
- Recoveries for the nine brood years (1983 through 1991) for which total escapement recoveries are available indicate 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, 1996 and 1997 (Table 2***). Note that no CWT were observed for the 1997 brood year. Consequently, no estimate of survival rate is calculated for 1997.***
- Annual distribution of the total fishing mortality on the Robertson Creek stock has been up-dated through 1999. 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 cohort) of coded-wire tagged (CWT) groups released from RCH 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). Note the last three broods have incomplete recoveries but are estimated based on observations to date and assuming average maturation rates from completed brood years.

Brood Year	Estimated % Survival Rate for Age-2 cohort CWT groups
1983	0.10%
1984	4.45%
1985	4.32%
1986	12.06%
1987	10.14%
1988	13.09%
1989	9.10%
1990	5.63%
1991	0.98%
1992	0.01%
1993	2.22%
1994	4.93%
1995	0.43%
1996	0.13%
1997	No CWT observed

4.2 Regression Statistics for Two Forecast Models

Table 4 summarizes the regression statistics and results of Prod2 and Prod3 regression models. The upper portion of these tables identify each sibling model, the x-value used in the 2000 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 2000 forecast and plotted in Appendix Figure 1 and 2. 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 (see section 3.4).

A difficulty for the year 2000 forecast was the absence of Age-2 CWT recoveries during 1999. Consequently, the methods described in this report would generate a zero abundance for the Age-3 cohort next year. However, Age-2 chinook were observed in the terminal area so a zero forecast is unlikely. In this analysis, the lowest Age-3 cohort observed in the past was assumed. The Age-3 cohort from the 1983 and 1996 brood years was estimated to be only about 4000 chinook. This value was applied as ocean Age-3 cohort size for year 2000 in both the Prod2 and Prod3 models.

Table 3. Distribution of total fishing mortality for RCH chinook stock; distributions based on cohort analysis through 1999 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	14.4	-	2.9	9.0	-	2.3	-	-	-	7.3	-	61.6	0	2.6	34.30	35.2	64.8
1986	19.3	13.5	2.6	9.2	8.8	7.2	2.6	0.8	2.1	1.9	6.0	4.0	1.06	21.0	55.37	71.0	29.0
1987	19.0	15.7	5.6	5.6	6.6	4.3	1.8	0.8	1.0	1.2	0.9	1.2	0.57	35.9	34.63	54.5	45.5
1988	20.9	14.3	2.6	7.5	7.0	2.9	0.3	0.5	1.7	1.9	7.3	1.3	11.35	20.7	42.10	62.0	38.1
1989	20.2	12.7	2.0	4.7	7.7	1.5	1.4	0.1	1.8	1.4	2.3	1.1	22.3	20.6	40.32	70.6	29.4
1990	29.7	13.5	3.9	11.6	6.7	2.2	0.9	-	2.1	1.5	2.9	0.6	12.53	12.0	49.28	65.3	34.7
1991	27.7	13.3	4.0	8.4	3.5	0.9	0.8	0.0	3.0	1.1	1.6	0.6	18.06	17.0	46.16	71.1	28.9
1992	26.4	11.4	4.4	27.5	12.0	1.3	0.5	0.1	2.1	2.2	3.1	0.3	0.56	8.4	59.10	64.9	35.1
1993	23.3	10.5	2.9	19.6	3.2	0.5	1.1	0.0	3.8	2.0	3.6	0.9	9.95	18.5	49.69	69.5	30.5
1994	23.0	11.9	1.4	6.8	6.0	1.3	0.2	-	4.6	1.5	5.6	0.7	15.2	21.9	47.43	75.4	24.6
1995	33.2	6.8	0.8	3.3	0.2	0.8	0.3	0.3	8.5	2.6	8.3	2.6	12.68	19.6	36.35	53.7	46.3
1996	44.2	8.6	1.9	5.1	4.5	0.3	0.1	0.1	13.3	6.6	4.9	4.5	0.22	5.6	30.52	32.4	67.6
1997	22.3	8.7	3.0	0.2	11.1	0.7	0.2	0.1	7.3	4.5	3.4	1.0	9.53	27.9	37.55	60.2	39.8
1998	29.5	9.9	0.1	-	6.7	-	0.0	-	7.5	4.1	7.7	1.0	6.46	27.0	37.95	57.0	43.0
1999	24.5	8.0	0.3	-	1.6	-	0.0	-	9.6	5.7	4.9	1.5	12.17	31.8	31.95	57.0	43.0
Average																	
1985-94	22.4	11.7	3.2	11.0	6.1	2.4	1.0	0.2	2.2	2.2	3.3	7.2	9.2	17.8	45.8	64.0	36.0
1995-99	30.7	8.4	1.2	1.7	4.8	0.4	0.1	0.1	9.2	4.7	5.8	2.1	8.2	22.4	34.9	52.1	47.9

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)	0	0	-93356	93356	27.060	0.897	76871
#5, Age (2+3) vs. Ages (4+5)	935	3750	-29646	37147	4.011	0.963	27498
#6, Ages (2+3+4) vs. Age 5 *	5866	2654	-7720	13029	0.452	0.953	8541
#7, Age 3 vs. Ages (4+5)	703	3491	-36214	43196	4.966	0.944	32693
#8, Ages (3+4) vs. Age 5 *	5783	2879	-7740	13497	0.498	0.950	8741

Mean absolute deviations by model:

Age 2 vs. Ages(3+4+5)	0.7069
Age (2+3) vs. Ages (4+5)	0.4246
Ages (2+3+4) vs. Age 5	0.5812
Age 3 vs. Ages (4+5)	0.4845
Ages (3+4) vs. Age 5	0.5410

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

	MODEL #3 OBS.	MODEL #3 PRED.	MODEL #5 OBS.	MODEL #5 PRED.	MODEL #6 OBS.	MODEL #6 PRED.	MODEL #7 OBS.	MODEL #7 PRED.	MODEL #8 OBS.	MODEL #8 PRED.
1983	3330	16107	1850	3775	326	808	1814	1718	326	593
1984	145793	93784	79366	134868	18753	30936	77303	152009	18753	32377
1985	140433	132290	85660	95968	22257	28580	83212	94445	22257	29006
1986	402754	241752	243657	186109	80700	54961	234780	185903	80700	56313
1987	314988	417354	183383	172425	50660	48345	177810	139843	50660	45731
1988	461386	504339	269045	299534	65770	74595	261810	269841	65770	71883
1989	236411	281991	143545	121418	35860	36290	139600	99529	35860	34727
1990	189060	53527	114720	88098	32000	28862	111200	99753	32000	30870
1991	32038	47389	17262	17163	3200	5902	16910	12560	3200	5622
1992	446	0	256	501	195	74	235	621	195	82
1993	59553	49776	31050	75058	5000	14689	30500	84237	5000	15249
1994	145958	20285	89326	83876	18420	28567	87300	101023	18420	31251
1995	3330	16107	1850	3775	326	808	1814	1718	326	593
1996	145793	93784	79366	134868	18753	30936	77303	152009	18753	32377

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)	0	0	-55748	55748	9.153	0.963	45903
#5, Age (2+3) vs. Ages (4+5) *	1118	1795	-17778	21368	1.605	0.987	16116
#6, Ages (2+3+4) vs. Age 5	9778	2011	-7690	11711	0.206	0.959	7987
#7, Age 3 vs. Ages (4+5)	870	1908	-14885	18702	2.194	0.990	13828
#8, Ages (3+4) vs. Age 5 *	9190	2188	-7299	11675	0.238	0.960	7811

Mean absolute deviations by model:

Age 2 vs. Ages(3+4+5)	0.4171
Age (2+3) vs. Ages (4+5)	0.2323
Ages (2+3+4) vs. Age 5	0.4491
Age 3 vs. Ages (4+5)	0.1939
Ages (3+4) vs. Age 5	0.4231

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	3330	10015	1850	3391	326	740	1814	2233	326	597
1984	145793	100347	79366	93054	18753	24077	77303	103515	18753	25288
1985	140433	107590	85660	72209	22257	21811	83212	72907	22257	22465
1986	402754	304907	243657	206170	80700	53171	234780	209762	80700	54190
1987	314988	372035	183383	204724	50660	52103	177810	190253	50660	50708
1988	461386	527733	269045	300538	65770	83962	261810	281570	65770	82474
1989	236411	275615	143545	138543	35860	39474	139600	123798	35860	38511
1990	189060	152111	114720	99533	32000	28964	111200	99597	32000	29603
1991	32038	34899	17262	22925	3200	5759	16910	22961	3200	5761
1992	446	146	256	226	195	37	235	274	195	39
1993	59553	49388	31050	42052	5000	10658	30500	45647	5000	11056
1994	145958	59490	89326	65111	18420	22698	87300	74901	18420	24808
1995	3330	10015	1850	3391	326	740	1814	2233	326	597
1996	145793	100347	79366	93054	18753	24077	77303	103515	18753	25288

4.3 Forecast

The predicted abundances shown in Table 4 are based on CWT groups shown in Appendix Table 4. The "total" production of Stamp River chinook is determined by expanding the predicted 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 2.19 for the age 3+4+5 cohort, 3.60 for the age 4+5 cohort, and 1.65 for the age 5+ cohort (see Section 3.3). The total cohort size available to ocean fisheries is presented in Table 5 as "Pre-fishery abundance".

Management scalars (i.e., proxy for management actions) may then be applied to average exploitation rates in fisheries to determine catches. In the case of the 2000 forecast, management scalars are only applied to Alaskan fisheries. For 2000, these were based on the Pacific Salmon Treaty agreements and initially used a harvest rate scalar of 0.5 in SEAK troll. The remaining cohort is identified as the expected terminal run assuming no fisheries in Canada (Table 5). At a later stage in the domestic fishery planning process, management scalars are derived for Canadian fisheries to reflect the conservation and allocation requirements for the Stamp/Somass River chinook.

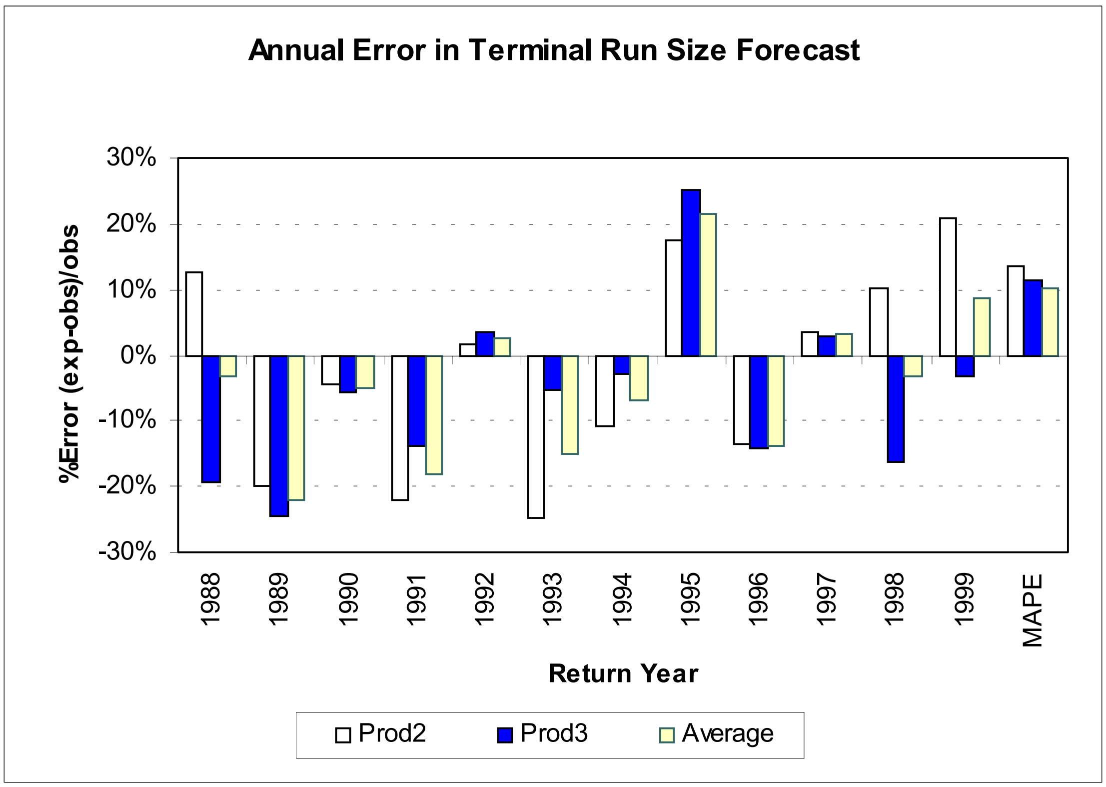
Table 5. Summary of forecasted abundance and terminal run size of Somass/Stamp River chinook salmon.

	Pre-Fishery Abundance	**Terminal Run with no Canadian fisheries**		
1. Model Prod 2 (Terminal vs Total Production)				
1997 brood	8765	1332		
1996 brood	13482	6886		
1995 brood	4754	3955		
Total	32894	11973		
2. Model Prod 3 (Total vs Total Production)				
1997 brood	8765	1332		
1996 brood	7100	3521		
1995 brood	3613	3005		
Total	15824	7859		
3. Average of Prod2, Prod3				
1997 brood	8765	1332		
1996 brood	10,291	5204		
1995 brood	4,184	3500		
Total	23240	10036		

When the age-specific forecasts are combined to predict the total terminal run to Barkley Sound (i.e, average of Prod2 and Prod3), the forecasting error is, on average, less than for the individual regression models. The mean absolute percent error (MAPE) for the average forecast value is 10% (Fig. 1). For the individual forecasting models, the MAPE for Prod 2 is 14% (range 2-25%) and for Prod 3 is 11% (range 3-25%), over the period 1988 to 1999. The error estimates were based on the deviations between forecast and observed returns, where:

- the terminal returns are calculated from the current regression models (i.e., leave one out assessment for the Prod2 and Prod3 models) and the actual preseason assumptions of exploitation rates used in past abundance forecasts.
- The observed total terminal return includes all catch plus escapement of Somass/Stamp River chinook in Area 23.

Figure 1. Average annual error for Prod2, Prod3, and average forecast models when applied to estimating the terminal run size of Somass chinook into Barkley Sound. Error is expressed as the percent deviation from the observed terminal run, 1988 - 1998. The mean absolute percent error (MAPE) is also shown.



In addition, as requested by the PSARC salmon Subcommittee, a cumulative probability distribution for the "average" forecast is shown in Appendix Figure 3. Only 12 data points are available to formulate the cumulative distribution of the forecasts. The forecast at 50% probability of occurrence is approximately a 9,000 return to the Somass/Stamp River, and 50% confidence bound on that estimated is 8200 to 9800.

4.4 Escapement Goal Range for Stamp River

As described in the Introduction, the current escapement goals range between a minimum established by PSARC in 1994 (PSARC Advisory Doc. S94-1) and the upper rebuilding target. The minimum target established in 1994 reflected the escapement levels immediately prior to the PST implementation in 1985. The basis for this determination was to protect wild stocks outside of the Somass River watershed, where the pre-PST escapement levels were considered very low after years of high exploitation.

Because of changing age and sex compositions between years, the minimum level was expressed as an egg requirement for hatchery and natural spawners in the Stamp River (i.e., 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 escapement required to meet the minimum goal in 2000 would be approximately 31,000 chinook.

Table 6. Derivation of the number of spawners needed to meet the minimum egg requirements in the 2000 chinook return.

	Age composition	**Fecundity**	**Proportion Female**	**Prespawn Mortality**	**Spawners**	**Eggs**
1997 brood	15%	4000	0.05	.20	4,747	759568
1996 brood	51%	4400	0.5	.20	15,935	28046362
1995 brood	34%	4800	0.75	.20	10,831	31194070
Total					31,514	60000000

The historic time series of spawners in the Stamp River is presented in Appendix Table 3. The minimum target of 50 million eggs in the Stamp River has not been achieved in 3 (1996, 1997, and 1999) out of 5 years since it was established in 1994. In addition, the minimum level was not achieved in 1987. The minimum escapement in the time series occurred in 1996 when less than 9 million eggs were deposited in the Stamp River.

4.5 Summary and Recommendations for Somass/Stamp River chinook.

- The 1999 terminal return of the Stamp River/RCH chinook was approximately 30,500; a 57% decline from the 1998 return. The age 5 chinook comprised the majority of the spawning stock, or 69% of the return. The age 3 and age 4 components were much lower than average. The age 3 return is production from the 1996 brood, which was the lowest escapement on record. For the first time, no CWT were recovered from an age class (age 2 jacks).
- The 2000 forecast for the Stamp River/RCH chinook is based on the forecasting method used since 1995. However, due to the absence of CWT from age 2 chinook, the forecast of age 3 chinook is based on the lowest observed cohort of age 3 chinook.
- The forecast total return of Stamp River/RCH chinook to the terminal area of Barkley Sound and Alberni Inlet is approximately 10,000 based on averaging the Prod2 and Prod3 models. The mean absolute percent error in the average forecast is 10%. The age structure of the return is projected to be: 13% Age 3, 52% Age 4, and 35% Age 5; with an expected sex ratio of 50% females (note that the forecast of Age 3 is very uncertain).
- The minimum spawning escapement goal is not achievable in 2000. With no fishing in Canada the expected escapement would provide a potential egg deposition of approximately 20 million eggs. This level of egg deposition would be the 4th lowest since the inception of the keystream program.
- This forecast represents about a two-third (66%) reduction in terminal abundance relative to 1999 returns.

5 *Extensive* escapement indicators for WCVI chinook

5.1 Methods

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 exploitation rates and expected returns to the naturally spawning chinook populations along the 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 index) to indicate trends in 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 annually surveyed (Table 7).

Since 1995, the snorkel method has been used to survey spawning escapement to the PSC index streams and these 15 additional streams. Surveys are scheduled approximately every 7 days, although weather and water flows often impact this schedule. The counts from the snorkel surveys are used to estimate escapement 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 1999, on the Gold River, a mark-recapture study was also conducted to determine chinook escapement.

Table 7. Rivers extensively surveyed (consistent method and effort) since 1995 to provide quantitative estimates of chinook escapement, including established "PSC" indicators plus additional indicators.

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

*Klaskish River not surveyed during 1999

5.2 Escapement Levels in Extensive Indicator Streams

In 1999, river levels were generally low through the migration and spawning period of chinook salmon. This allowed weekly surveys to take place with good coverage throughout the spawning period.

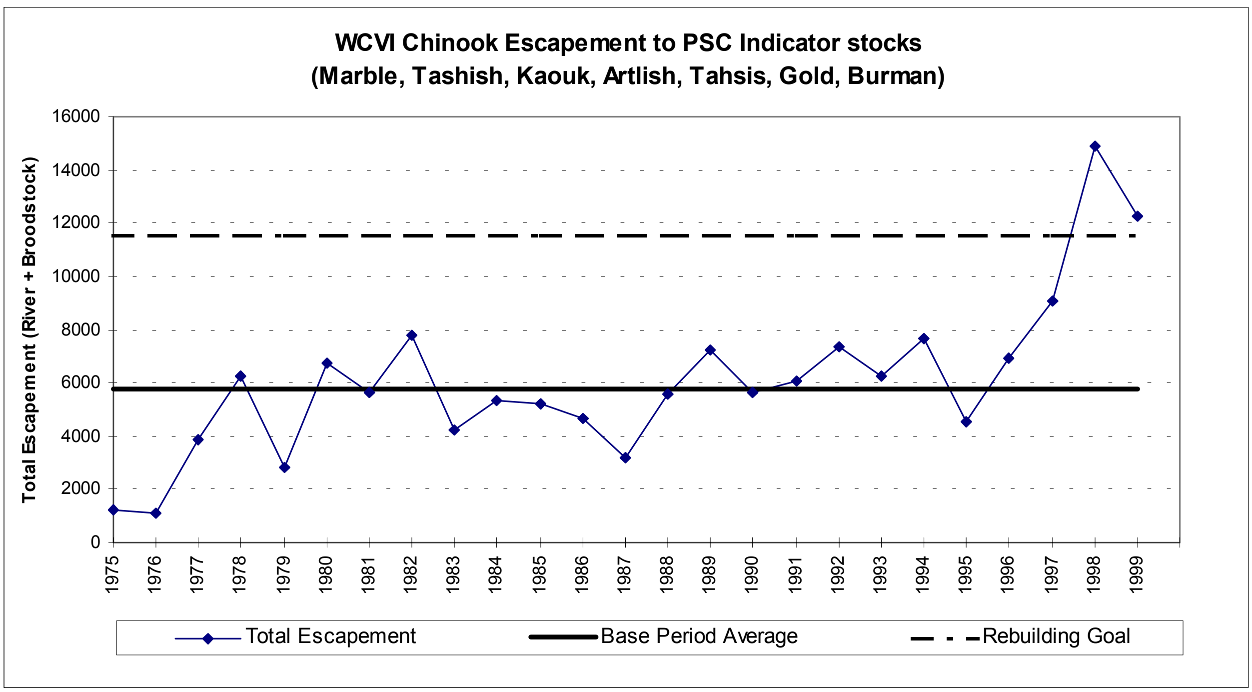
In 1999, the aggregate PSC index exceeded the interim rebuilding goal of 11,500 chinook (double the base period 1979-82 average escapement), but were generally lower than the 1998 escapement estimates (Figure 2). The total escapement to the indicator group was 12,256 or a decline of approximately 18% relative to 1998.

Over all the 22 extensively surveyed systems (not including the major hatchery systems), the decline in total escapement from 1998 to 1999 was approximately 28%. In both the Conuma and Nitinat rivers, systems with major hatcheries, the decline was about 40%.

Individually, returns to the extensively surveyed systems were varied. Within the PSC index group, the Burman River had a 25% decrease in adult escapement while escapement to the Tahsis River, also in Area 25, increased by almost 300% relative to 1998 escapement. In Area 26, the Kaouk River adult escapement was 55% lower than the 1998 escapement while the Artlish River exceeded last years escapement total by almost double. The Area 27 indicator (Marble River) had a 20% decrease in escapement from last year (Marble also has substantial enhanced production).

In the additional "extensive" indicators chinook returns in 1999 also varied. On southwest Vancouver Island, seven streams from Areas 20 to 24 were surveyed The 1999 escapement to the San Juan River (Area 20) was the second highest since the start of the base period. The Nahmint River (Area 23) also had its second highest escapement since the start of base period (Note: the recreational fishery was closed in early September due to a general conservation concern for chinook). However, the Sarita River (Area 23) had dramatically decreased in 1999, with an escapement estimate 60% lower than 1998.

Figure 2. Trend in adult chinook escapement of PSC escapement indicator stocks, 1975 to 1998. The solid line indicates the base period (1979-1982) average escapement. The broken line indicates the PSC rebuilding goal (double the base period average).



Age composition of WCVI chinook escapement was estimated from a cross section of the extensive indicators. The samples were collected by hatchery staff prior to broodstock collection, or by dedicated sampling crews using beach seines in the river, or using test vessel seines in the estuary. The resulting preliminary age data indicates that five year-olds generally dominated the returns, while the age two, three, and four components were weak (Table 8). Under normal conditions and stable production the expected age composition would be 1-3% age 2, 20-30% age 3, 60-70% age 4, 10-20% age 5+ (i.e., average age of maturity from cohort analyses).

The average age composition in WCVI indicator streams was very similar to that determined for the

Stamp River/RCH chinook terminal return.

Table 8. Age Composition from scale analysis for extensively surveyed systems along the WCVI.

SYSTEM	Age 2	Age 3	Age 4	Age 5	Age 6	Sample Size
San Juan R (A20)	0.0%	7.1%	23.1%	65.2%	4.6%	411
Nitinat R (A22)	1.0%	5.3%	55.4%	38.0%	0.4%	1136
Sarita R (A23)	0.0%	4.5%	6.3%	88.6%	0.6%	176
Sproat R (A23)	0.0%	0.0%	0.0%	100.0%	0.0%	13
Toquart R (A23)	0.0%	5.9%	23.5%	64.7%	5.9%	17
Thornton C (A23)	4.1%	43.5%	26.5%	23.8%	2.0%	147
Tranquil R (A24)	0.0%	7.9%	65.3%	24.8%	2.0%	101
Burman R (A25)	0.0%	2.0%	8.0%	88.0%	2.0%	50
Gold R (A25)	0.0%	0.0%	4.5%	93.9%	1.5%	66
Conuma R (A25)	0.2%	13.5%	29.6%	56.1%	0.7%	565
Tahsis R (A25)	0.0%	1.1%	58.2%	39.7%	1.1%	189
Kaouk R (A26)	0.0%	0.0%	7.7%	92.3%	0.0%	13
Tahsish R (A26)	0.0%	0.0%	0.0%	100.0%	0.0%	13
Cayaeghle/Colonial (A27)	0.0%	0.0%	76.3%	23.7%	0.0%	38
Marble R (A27)	0.0%	4.3%	41.0%	54.3%	0.5%	210
						3145
Unweighted average age composition	0.3%	6.3%	28.4%	63.5%	1.4%	
Standard Error in unweighted average	1.1%	11.0%	25.4%	28.9%	1.7%	
Age composition of Stamp River/RCH terminal return	0.7%	7.1%	22.9%	68.9%	0.4%	

5.3 Forecast Returns for extensively surveyed systems along the WCVI

Due to the lack of rigorous data, as is collected for the Somass/Stamp River return, it is not possible to establish quantitative forecasts for rivers outside the Somass/Stamp system. Consequently, a simplified approach is applied using the relative return rate forecast for the Somass/Stamp River to the other WCVI systems. Specifically, we assume the 66% decline in escapement from 1999 to 2000, and the forecast of 50% females in the escapement. The results are shown in Table 9. Since only two of the extensively surveyed systems (San Juan and Sarita rivers) experienced greater declines in 1999 than was seen in the Somass/Stamp, the escapement levels projected in Table 9 are likely a worst case scenario.

Table 9. Forecast of year 2000 total escapement and female spawners in selected WCVI indicator streams assuming a 66% reduction from 1999 levels (RCH forecast) and expected 50% female. Not included are systems influenced by major hatcheries at Conuma and Nitinat.

River	**Indicator, Production Type[1]**	**Range in Observed Escapement[2]**	**Mean Escapement[2]**	**1999 Total Escapement**	**2000 Forecast Escapement**	**2000 Forecast Females**
San Juan R (A20)	Enhanced	300-4600	900	1,620	567	284
Sarita R (A23)	Enhanced	130-2400	900	767	268	134
Nahmint R (A23)	Enhanced	200-784	300	931	326	163
Bedwell R (A24)	Wild	270-700	200	160	56	28
Megin R (A24)	Wild	160-800	200	236	83	41
Moyeha R (A24)	Wild	90-400	150	239	84	42
Leiner River (A25)	Enhanced	300-715	300	822	288	144
Tahsis R (A25)	PSC, Enhanced	380-1400	400	1,731	606	303
Gold R (A25)	PSC, Enhanced	800-3600	1500	2,000	700	350
Burman R (A25)	PSC, Enhanced	600-3200	1100	2,399	840	420
Zeballos R (A25)	Wild	150-900	200	686	240	120
Kaouk R (A26)	PSC, Wild	150-800	200	453	159	79
Artlish R (A26)	PSC, Wild	100-700	200	539	189	94
Tashish R (A26)	PSC, Wild	250-1500	600	879	308	154
Marble R (A27)	PSC, Enhanced	1000-5300	2400	4,185	1,465	732

[1] PSC indicators of escapement as defined in Chinook Rebuilding Program. Production type "Enhanced" indicates small scale supplementation of the wild stock by removal of natural spawners for broodstock.
[2] Based on extensive survey program initiated in 1993 to 1995, depending on river and area. Estimates are Area Under Curve estimates of total escapement.

5.4 Summary and Recommendations for Systems Outside the Somass/Stamp River

- The total escapement to the PSC indicator stocks was above goal again in 1999.
- However, there were declines in escapement in most systems relative to 1998 levels. Over all systems surveyed (excluding two major hatchery systems), the 1999 escapement declined 28% from 1998 levels. For the PSC index subset, the decline was about 20%. The decline was generally greater in the south than in the north. The declines in chinook escapements along the WCVI were generally less than the 57% decline experienced in the Somass/Stamp terminal run. Only the San Juan River and the Sarita River in southwest Vancouver Island experienced greater declines.
- Age-5 chinook generally dominated the returns in WCVI rivers. On average, in rivers sampled, the age-5 component comprised 64% of the spawning population, and age-3 and age-4 components were weak. Overall, age compositions were very similar to that in the Stamp River/RCH indicator stock.
- We recommend using the expected change from 1999 to 2000 in the Stamp River return as a conservative estimate of change in other systems. The resulting forecasts of year 2000 escapements for WCVI chinook populations are near lows of escapements observed since 1994 when extensive survey of WCVI chinook escapements began.

6 Literature cited

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7 Appendices

Appendix Table 1. 1999 Terminal Run Accounting for Somass/Stamp River Chinook

Appendix Table 2. 1999 Accounting of Chinook Escapement into the Stamp River and Robertson Creek Hatchery

Appendix Table 3. Historic Chinook Escapements and egg depositions into the Stamp River

Appendix Table 4. CWT Tagcodes used in the cohort analysis and forecasting of Robertson Creek Hatchery stock

Appendix Figure 1. Model Prod3 (total production to total ocean production) sibling regressions for the RCH indicator stock, for years of age-structured terminal run, 1985-1999.

Appendix Figure 2. Model Prod2 (total production to total ocean production) sibling regressions for the RCH indicator stock, for years of age-structured terminal run, 1985-1999.

Appendix Figure 3. Cumulative probability distribution of the “average” forecast (average of Prod2 and Prod3) for the year 2000 terminal run to the Stamp River/RCH indicator chinook stock (WCVI).

Appendix Table 1. 1999 Stamp River (Somass) Chinook Terminal Run, Catch and Escapement

			AGE COMPOSITION					
FISHERY	**DATE**	CATCH	Aged	Age 2	3	4	5	6
ALBERNI INLET FISHERIES								
Test Fishery *proj=4090*	na	0						
Commercial Gill Net *proj=7500*	na	45		*0.0%*	*3.4%*	*25.0%*	*71.6%*	*0.0%*
Alberni Inlet Sport *(pr 4060)*	June	0						
	July	21		*2.4%*	*13.1%*	*22.6%*	*61.9%*	*0.0%*
	August	4,801	84	2.4%	13.1%	22.6%	61.9%	0.0%
	to Sept. 14	2,763	331	0.0%	4.5%	18.1%	77.3%	0.0%
Total Alberni Inlet sport		**7,585**		**115**	**757**	**1,592**	**5,122**	**0**
Total catch of Stamp R chinook in Alberni		**7,355**		**115**	**757**	**1,592**	**4,892**	**0**
Age composition Stamp chinook only				**1.6%**	**10.3%**	**21.6%**	**66.5%**	**0.0%**
Somass Food & Sale Fishery *(proj 9095)*								
Elder Fishery	25-Aug	21		*0.0%*	*3.4%*	*25.0%*	*71.6%*	*0.0%*
Elder Fishery	26-Aug	9		*0.0%*	*3.4%*	*25.0%*	*71.6%*	*0.0%*
Elder Fishery	30-Aug	40		*0.0%*	*3.4%*	*25.0%*	*71.6%*	*0.0%*
Elder Fishery		180		*0.0%*	*3.4%*	*25.0%*	*71.6%*	*0.0%*
SFSF	07-Sep	3,136	100	0.0%	3.4%	25.0%	71.6%	0.0%
SFSF	16-Sep	205		*0.0%*	*3.4%*	*25.0%*	*71.6%*	*0.0%*
Protest fish								
Total Somass Food & Sale Fishery		**3,591**		**0**	**122**	**898**	**2,571**	**0**
Total catch of Stamp R chinook in SFSF		**3,591**		**0**	**122**	**898**	**2,571**	**0**
Age composition Stamp chinook only				**0.0%**	**3.4%**	**25.0%**	**71.6%**	**0.0%**
Total Catch All Gear		**11,176**		**115**	**879**	**2,489**	**7,693**	**0**
Total catch of Stamp R chinook in Alberni Inlet		**10,946**		**115**	**879**	**2,489**	**7,463**	**0**
Age composition Stamp chinook only				**1.0%**	**8.0%**	**22.7%**	**68.2%**	**0.0%**
Total exp CWT in Alberni Inlet catch		5,279		0	0	1,026	4,254	0
Total natural origin chinook in Alberni Inlet catch		5,667		115	879	1,463	3,209	0
ESCAPEMENT ABOVE STAMP FALLS								
Hatchery broodstock, morts, surplus		2,162		25	49	357	1,722	9
Inriver escapement, potential spawners		15,375		63	865	3,798	10,525	124
ESCAPEMENT TOTAL all ages		**17,537**		**88**	**914**	**4,154**	**12,248**	**133**
Age composition				**0.5%**	**5.2%**	**23.7%**	**69.8%**	**0.8%**
Escapement of adults only		17,449						
Escapement hatchery component based on expCWT		11,867		-	450	2,974	8,419	25
Total inriver female spawners ni pre-spawn morts		9,964						-
prespawn mortality		1,552						
Effective natural spawning females		8,413						
Total inriver eggs		39.8M						
BARKLEY SOUND FISHERIES								
A23B Creel Survey Estimated Total Catch CN		40,361	= catch during extended creel survey period Jun-Sep					
A23B Creel Survey Estimated Total Catch CN		25,634	= catch during RBT migration only, Aug-Sep only					
RBT total exp cwt (Aug-Sep)		1,191		0	210	210	771	0
				0.0%	17.7%	17.7%	64.7%	0.0%
Barkley Snd total catch of Stamp R chinook		**2,049**		**0**	**362**	**362**	**1,326**	**0**
Total catch of Stamp chinook in sport fishery		9,404		115	1,118	1,953	6,218	0
TOTAL TERMINAL RUN STAMP CHINOOK		**30,532**		**203**	**2,155**	**7,005**	**21,037**	**133**
Age composition Stamp chinook only				**0.7%**	**7.1%**	**22.9%**	**68.9%**	**0.4%**

Appendix Table 2. Total escapement into Stamp River, hatchery and natural spawning.

A. TOTAL COUNT THROUGH STAMP FALLS FISHWAY

	Adults	Jacks	Total Count
Unadjusted Daytime Observations at Stamp Falls:	13646	807	14453
Adjusted daytime count from tape verification:	13866	684	14550
Adjusted swim survey count:	104	0	104
Night time count from tape verification:	3479	66	3545
Adjusted jack count after removal of 'jimmies':		88	
Final adjusted counts **(above Stamp Falls)**:	**17449**	**88**	**17537**

B. HATCHERY COMPONENT

	Total Swim-in	Sample Size	Released	Marked	unMarked	Sex	C/S	%MI
Males (incl jacks):								
Females:	2,531	1,851	680	98	1,753	F	1.37	5.29%
Jacks:	25	25		-	25	J	1.00	0.00%
Adult males:	1,354	207	1147	6	201	M	6.54	2.90%
Adjustment factor (J to M):		-		-				
Totals:	**3,910**	**2,083**	**1,827**	**104**	**1,979**			

CWT recoveries by sex:

	Expansion	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	Observed	0	1	1	4		6	6
	Estimated		6.54	6.54	26.16		39	39
	Expanded		306.51	380.95	583.59		1271	1271
Female	Observed			10	82	1	93	93
	Estimated			13.67	112.12	1.37	127	127
	Expanded			330.30	2,429.31	25.02	2785	2785
Females fr Dam	Observed				2		2	2
	Estimated				2		2	2
	Expanded				49.75		50	50
Males fr Dam	Observed						0	0
	Estimated						0	0
	Expanded						0	0
TOTAL (swim-in)	Expanded	0	307	711	3013	25	4056	4056
TOTAL (swim-in+GCL)	Expanded	0	307	711	3063	25	4105	4105

Scale Age composition (from biosample fish only, excluding cwt samples):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	2	41	68	56		167	165
Females			60	320	1	381	381
Female/ dam	0		9	56		65	65
Male/ dam		1	3			4	4

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

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	ttl sample
Males		23.3%	36.5%	40.2%	0.0%	100%	204
Females		0.0%	14.5%	85.0%	0.5%	100%	508
Males (GCL Dam only)		25.0%	75.0%	0.0%	0.0%	100%	4
Females (GCL Dam only)		0.0%	13.4%	86.6%	0.0%	100%	67

Age composition based on Expanded CWT %:

	Age 2	Age 3	Age 4	Age 5	Age 6	Total
Males	0.0%	24.1%	30.0%	45.9%	0.0%	100.0%
Females	0.0%	0.0%	11.9%	87.2%	0.9%	100.0%
Female/ dam	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%

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

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males (swim-in)	25	315	494	545	0	1379	1354
Females (swim-in)	0	0	367	2152	12	2531	2531
Total (swim-in)	25	315	861	2697	12	3910	3885
Females from GCL	-	-	10	65	-	75	75
Males from GCL	-	1	3	-	-	4	4
Total (swim-in + GCL)	25	316	874	2762	12	3989	3964
% hatchery (exp cwt) - swim-ins only	*0%*	*97%*	*83%*	*112%*		*104%*	*104%*

NET RETURN TO HATCHERY BY AGE - excluding releases (based on pooled samples):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males (swim-in)	25	48	76	83	0	232	207
Females (swim-in)	0	0	268	1574	9	1851	1851
Total (swim-in)	25	48	344	1657	9	2083	2058
Females from GCL	0	0	10	65	0	75	75
Males from GCL	0	1	3	0	0	4	4
Net swim-in + GCL	25	49	357	1722	9	2162	2137

0.349 Sex Ratio (Adult Males/Total Adult):
0.006 Ratio of Jacks to Total Males:

Appendix Table 2 cont'd. Total escapement into Stamp River, hatchery and natural spawning.

C. INRIVER POPULATION

INRIVER:			
	Total spawners:	13,627	=Escapement estimate-hatchery, includes jacks
	River Adults:	13,564	=Escapement estimate-hatchery
	In-river Jack estimate (a):	63	=Escapement estimate-hatchery
	Number of males(incl jacks):	4,268	=total inriver * unweighted pooled sex ratio
	Alternate in-river jack est (b):	25	=based on jack/male ratio in hatchery
		0.281	=Sex ratio in sample(Adult males / Total Adult)
		0.315	= Unweighted males (pooled Hatchery & river)

	Total popn.	Sample popn.	No. sampled	Sex	C/S Rate	Marks	%MI
Chosen jack est (a):	63	63	9	J	7.00	0	0.00%
Number of adult males:	4,205	4,205	763	M	5.51	19	2.49%
Number of females:	9,359	9,359	1,955	F	4.79	59	3.02%

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	-	1	10	6		17	17
	Estimated	0	6	55	33		94	94
	Expanded	0	6	1459	1,297		2,762	2,762
Female	Observed	0	1	8	36	1	46	46
	Estimated	0	5	38	172	5	220	220
	Expanded	0	138	804	4,059	107	5,107	5,107
Total	Expanded	-	143	2,263	5,356		7,762	7,762

Scale Age composition (number at age in sample - jacks applied directly):

						Ttl Jacks	Total Adults
Males	63	38	119	131		63	288
Females	0	2	37	251	2	0	291

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

Males	100.0%	11.4%	45.7%	42.9%	0.0%	100.0%
Females	0.0%	1.3%	14.7%	82.8%	1.3%	100.0%

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

This excludes hatchery swim-ins released back to the river.

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	63	480	1921	1803	0	4268	4205
Females	0	119	1372	7747	121	9359	9359
Total	63	599	3293	9551	121	13627	13564
% hatchery (exp cwt)	*0%*	*24%*	*69%*	*56%*		*57%*	*57%*
% hatchery (otolith)							
Otolith sample size							

In-River return of 'hatchery releases' by age (based on pooled samples from hatchery):

	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	0	267	419	461	0	1147	1147
Females	0	0	99	578	3	680	680
Total	0	267	517	1040	3	1827	1827

GCL Broodstock:

	Total popn.	Sample popn.	No. sampled	Sex	C/S Rate
Jacks:	-	-	-	J	#DIV/0!
Number of adult males:	4	4	4	M	1.00
Number of females:	75	75	75	F	1.00

COMPOSITION OF GCL SAMPLES:	Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males from GCL	0	1	3	0	0	4	4
Females from GCL	0	0	10	65	0	75	75

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	63	746	2337	2265	0	5411	5348
Females	0	119	1461	8261	124	9964	9964
Total	63	865	3798	10525	124	15375	15312
Prespawn Mortality (Females only)	0%	8%	8%	17%	17%		
Effective inriver female spawners	0	110	1344	6856	103	8413	8413
Fecundity		4000	4400	4800	5200		
Total Egg Deposition		**438,313**	**5,914,038**	**32,909,988**	**534,595**	**39,796,933**	

Appendix Table 2 cont'd. Total escapement into Stamp River, hatchery and natural spawning.

D. TOTAL ESCAPEMENT RUN TO STAMP RIVER <u>ABOVE</u> STAMP FALLS (spawning escapement + prespawn morts + hatchery removals).

		Age 2	Age 3	Age 4	Age 5	Age 6	Total	Ttl adult
Males	-	88	795	2,415	2,348	-	5,647	5,559
Females	-	-	119	1,739	9,899	132	11,890	11,890
Total	-	88	914	4,155	12,248	132	17,537	17449
Total expanded CWT		-	450	2,974	8,419	25	11,868	11,868
% hatchery (exp cwt)		*0%*	*49%*	*72%*	*69%*	*19%*	*68%*	*68%*

<u>notes:</u>

total fishway count includes swim count Sep 3, fishway sep 3 - nov 5
fishway counts were adjusted for observer error
fishway counts were adjusted for for night time migration (using video of night migration)
note: Adjusted counts = unweighted average of: (verified jack/verified adult)*total adult escapement and (verifiedjack/realtime jack)*realtime jack count to adjust jack count (including jimmies). Jimmies then removed using (jimmies/jacks+jimmies).
**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.
note: GCL broodstock. Samples captured and released directly above the dam were not considered as part of the sample.
note: inriver c/s. Jacks have been removed from total spawners before the unweighted ratio was applied
note: inriver c/s. Hatchery releases excluded as part of sample popn. They are added in lower down.

Appendix Table 3. Total escapement into the Stamp River, including natural spawners, potential eggs, and hatchery removals during the period of the intensive “keystream” surveys, 1985-99.

Return Year	**Total Natural Spawners**	**Total Adult Spawners**	**Potential Eggs Prior to Spawning**	**Total Hatchery Swimins**	**Total Adults in Hatchery**	**Total Adult Escapement**
1985	74,941	74,279	167,282,000	19,076	18,875	93,154
1986	29,306	29,306	69,225,560	13,935	6,983	36,289
1987	15,454	14,491	9,744,800	38,694	36,156	50,647
1988	62,411	54,305	112,514,000	14,533	12,505	66,810
1989	50,990	44,786	67,998,400	28,929	18,258	63,044
1990	81,840	76,064	107,049,600	45,850	35,998	112,062
1991	96,907	85,843	149,254,400	35,354	30,425	116,268
1992	119,986	117,248	248,124,800	25,126	24,398	141,646
1993	77,644	76,487	176,551,600	20,415	20,043	96,530
1994	47,498	46,605	120,852,800	11,132	11,105	57,710
1995	25,460	23,313	80,042,198	4,990	4,522	27,834
1996	11,121	9,410	8,631,450	18,829	17,920	27,330
1997	13,623	12,785	14,140,245	19,415	19,309	32,095
1998	28,263	28,044	60,617,712	11,876	11,847	39,891
1999	15,375	15,312	47,199,407	2,162	2,137	17,449
2000 forecast	10,000	10,000	20,000,000	na	na	na

Appendix Table 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
020647
020153
020152
020151
@90
021549
021550
021551
021552
021553
021208
021209
@91
180620
180621
180622
180623
180802
180803
180804
180805

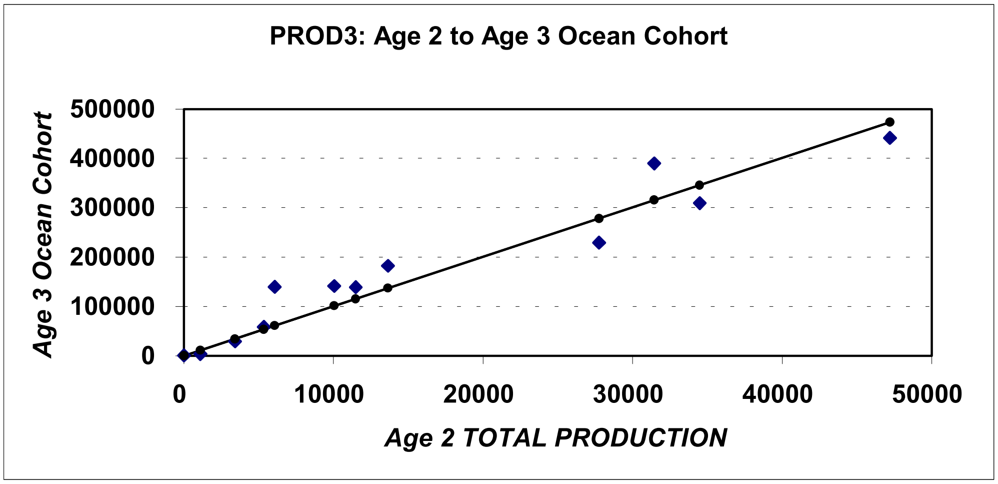
@92
180259
180260
180261
180262
180624
180625
180626
180627
@93
181539
181540
181541
181542
181543
181544
181545
181546
@94
181455
181456
181457
181458
181459
181460
182220
182221
182222
182223
182224
182225
@95
182226
182227
182228
182229
182230
182231
182502
182503
182504
182505
182506
182507
182508

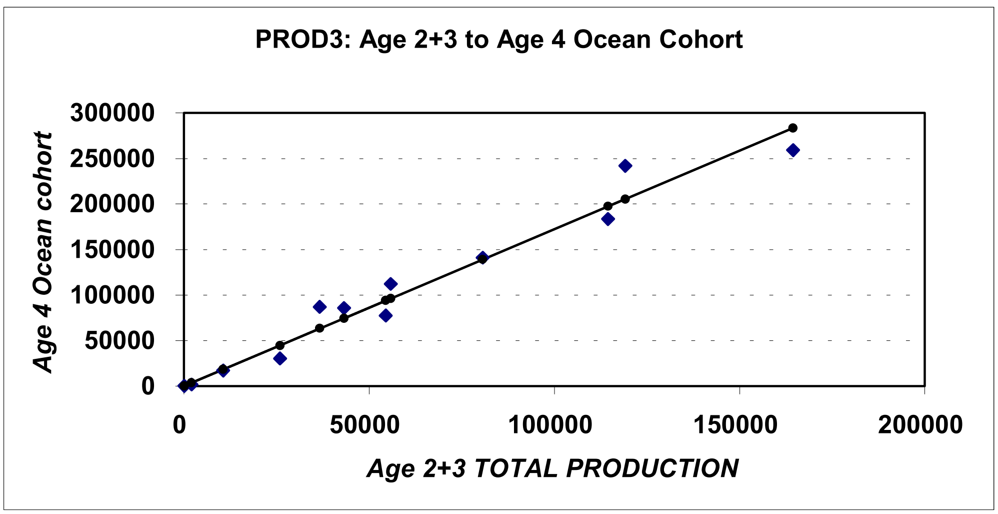
@96
182232
182233
182234
182235
182236
182237
182541
182543
182542
182544
182545
182546
182547

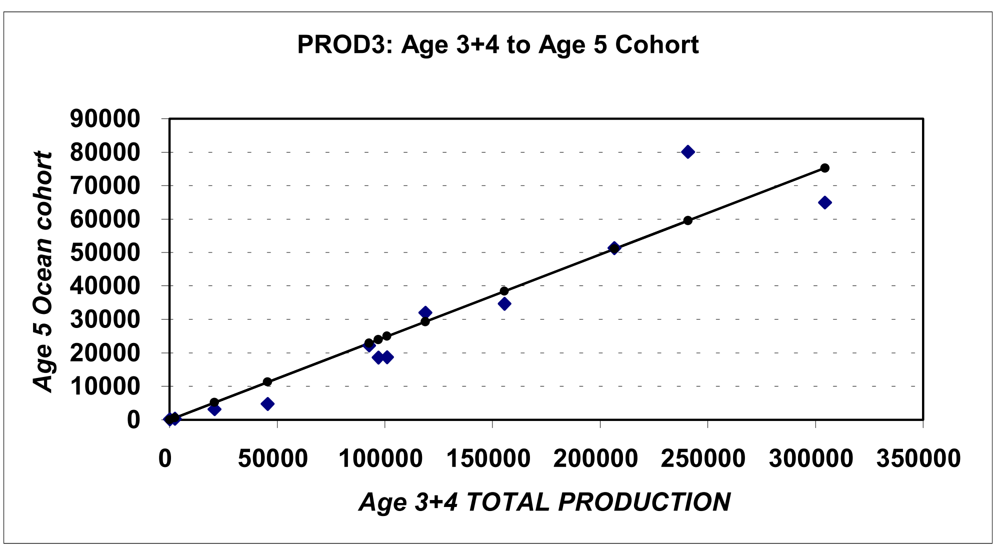
@97 *
182814
182815
182816
182817
183153
183154
183155
183156
183157
183158

* NO CWT recoveries from this brood year

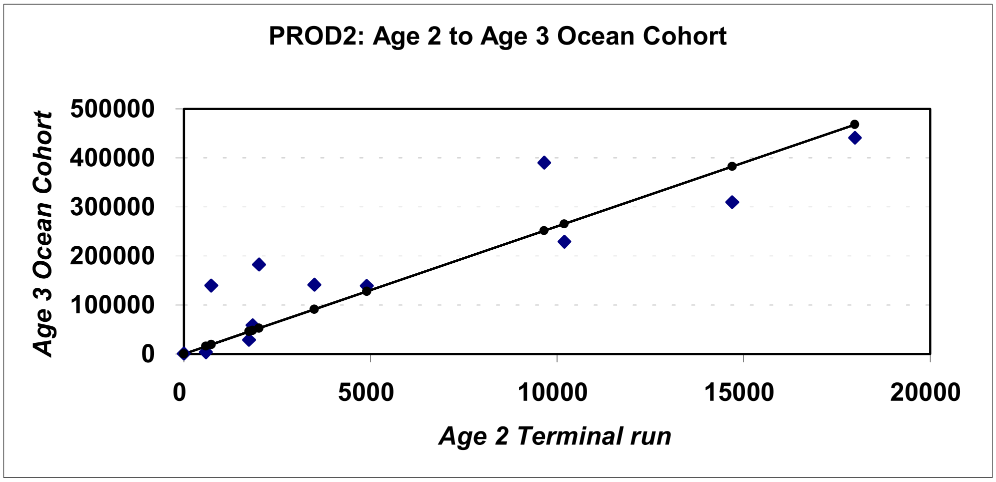
Appendix Figure 1. Model "Prod3" sibling relationships.

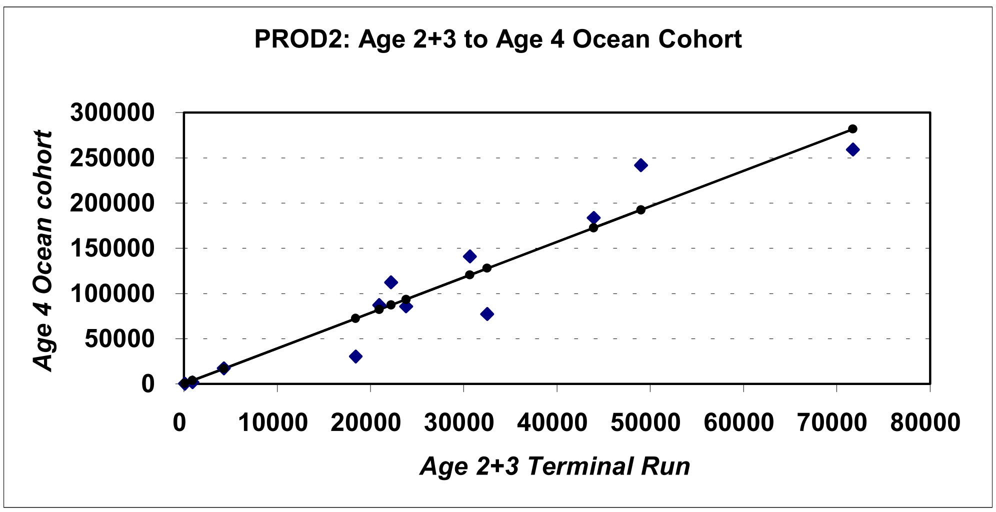


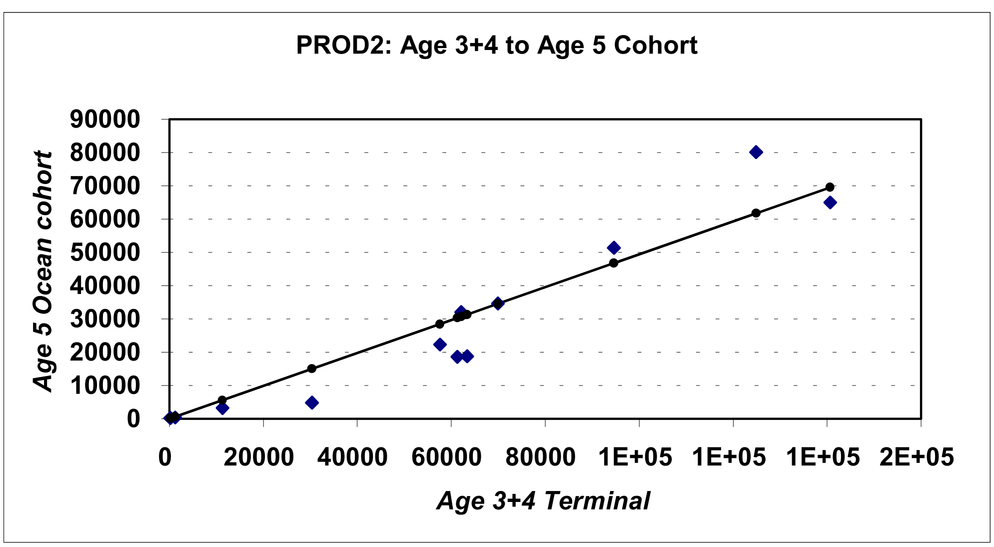




Appendix Figure 2. Model "Prod2" sibling relationships.







Appendix Figure 3. Cumulative probability distribution of the "average" forecast (average of Prod2 and Prod3) for the year 2000 terminal run to the Stamp River/RCH indicator chinook stock (WCVI). Horizontal dashed lines represent the 25%, 50%, and 75% cumulative probabilities. The vertical solid line is the simple average value of the Prod2 and Prod3 models and equals 10036 chinook.