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# Status of Clockwork Chum Salmon Stock and Review of the Clockwork Management Strategy

Paul Ryall[1], Clyde Murray[2], Vic Palermo[2], Don Bailey[3] and Din Chen[2]

[1] Fisheries and Oceans Canada
South Coast Division, Operations Branch
Nanaimo, B.C. V9R 5K6

[2] Fisheries and Oceans Canada
Stock Assessment Division, Science Branch
Pacific Biological Station
Nanaimo, B.C. V9R 5K6

[3] Fisheries and Oceans Canada
Program Coordination and Assessment Division, Habitat and Enhancement Branch
Vancouver, B.C.

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## Abstract

This review examines the assessment of Inner South Coast (ISC) Clockwork chum stocks and the corresponding fishery management. The purpose of the paper is to provide: 1) an up to date stock-recruit analysis, including the large 1997 returns, for both Fraser and non-Fraser Clockwork stocks. The analysis focuses on wild stocks but an assessment of the enhanced component is also presented, 2) an updated assessment of escapement patterns, 3) an updated assessment of the Mission fry estimates and it's relationship to subsequent returns, 4) a retrospective analysis of in-season run size estimates in Johnstone Strait, and 5) a review of the fishery management (1983 through 1997) with respect to the effectiveness of the Clockwork management strategy.

Stock-recruit analysis was done on the 1959-1992 brood years for wild Fraser and non-Fraser Clockwork chum. Results show that for Fraser chum, the optimal harvest rate is approximately 45% which is almost identical to that found by Joyce and Cass (PSARC 92-02). However, unlike the earlier report, the optimal stock size was found to be 738,690 which is substantially greater than 485,320 estimated by Joyce and Cass. Further, evidence of density dependence was found for Fraser stocks that was not found in earlier work. For the aggregate wild stocks, the optimal harvest rate was 44% with optimum stock size calculated at 2.6 million and evidence for density dependence was also noted.

Chum escapement patterns and production has varied based on stock. For the overall aggregate production has increased. However, it would appear that not all areas have responded equally. Fraser River chum stocks have shown greater production and increased escapement relative to the other stocks and are driving the aggregate. Some stocks appear to be decreasing in spite of management and conservation actions. Specifically, escapement records to Upper Vancouver Island, Kingcome Inlet, Bond and Knight Inlets and Toba Inlet show declines in escapement levels. Factors such as lack of escapement enumeration effort and habitat issues may be responsible for the decline and these need to be explored in greater detail. Increased escapement levels for certain ISC chum stocks may be required to stop marked declines in escapement.

Heuristic analysis of the predictive ability of the Mission downstream fry data has shown that although the data correlates with subsequent stock size, it is still too variable to be considered a useful tool for prediction.

Six models were tested and analyzed as to their value for in-season stock size estimation. In general, no one model performed markedly better than any other model. Although run size estimates have been reasonably accurate in comparisons to the final run size, there have been a number of years when the in-season and final estimates have been significantly different. The current models are dependent upon the assumption of average migratory timing of the Clockwork chum stocks. In-season models based upon average migratory timing will under or over-forecast population abundance's because of run timing variability. Incorporating sex ratios with the best performing run model may improve forecasts over the best model without sex ratios.

The results from the review would indicate that overall the Clockwork management strategy has been successful in achieving a number of its objectives. Namely the strategy has allowed for limited commercial fishing in most years, increased wild escapement levels overall, and helped to increase our understanding of the optimal target escapement levels. When viewed from an aggregate viewpoint and taking the associated uncertainties into account, the Clockwork management strategy has worked reasonably well in meeting escapement and harvest rate targets and therefore should continue. That said, there remains significant concern over the level of escapement enumeration and accuracy of the escapement estimates upon which the Clockwork strategy and this stock status review depends. There is a need to standardize data collection methods to improve escapement estimates.

# Résumé

Le présent examen porte sur l'évaluation des stocks de saumon kéta de la côte sud intérieure (ISC) gérés selon le modèle « Clockwork » et sur la gestion des pêches qui en est faite. Le document a pour objet de fournir : 1) une analyse stock-recrutement à jour, y compris des importantes remontées de 1997, pour les stocks du Fraser ou d'autres cours d'eau gérés selon le modèle Clockwork, l'accent est mis sur les stocks sauvages, mais une évaluation de la composante mise en valeur est aussi présentée; 2) une évaluation à jour du régime des échappées; 3) une évaluation à jour du nombre estimé d'alevins dans la Mission et des rapports avec les remontées ultérieures; 4) une analyse rétrospective des estimations en cours de saison de l'effectif des remontées dans le détroit Johnstone et 5) un examen de la gestion des pêches (de 1983 à 1997) portant sur l'efficacité de la stratégie de gestion Clockwork.

L'analyse stock-recrutement a été effectuée pour les années de ponte 1959-1992 des saumons kéta sauvages du Fraser et d'autres cours d'eau gérés par modèle Clockwork. Les résultats montrent que, pour le kéta du Fraser, le taux de récolte optimal s'élève à 45 % environ, soit pratiquement à la valeur déterminée par Joyce et Cass (CEESP 92-02). Mais au contraire du rapport précédent, l'effectif optimal du stock s'élevait à 738 690, ce qui est de beaucoup supérieur à l'estimation de Joyce et Cass de 485 320. En outre, une dépendance envers la densité, qui n'avait pas été décelée antérieurement, a été notée pour les stocks du Fraser. En ce qui a trait à l'ensemble des stocks sauvages, le taux de récolte optimal était de 44 % pour un effectif optimum de 2,6 millions et l'on a aussi noté une dépendance envers la densité.

L'allure des échappées du kéta et la production ont varié selon les stocks, mais la production totale s'est accrue. Par ailleurs, ce phénomène n'a pas été noté également dans toutes les zones. Les stocks de kéta du Fraser sont ceux dont la production et les échappées ont le plus augmenté et ce sont eux qui donnent l'allure à l'ensemble. Certains stocks semblent être en déclin en dépit des mesures de gestion et de conservation adoptées. Plus précisément, on a noté des échappées records pour Upper Vancouver Island, mais un déclin pour Kingcome Inlet, Bond et Knight Inlets et Toba Inlet. Certains facteurs, comme l'insuffisance des efforts consacrés au dénombrement des échappées et des problèmes relatifs à l'habitat, peuvent expliquer ce déclin et devront être examinés de façon plus approfondie. Il pourra s'avérer nécessaire d'accroître les échappées de certains stocks de kéta de la ISC pour mettre fin au déclin marqué des échappées.

Une analyse heuristique de la capacité prévisionnelle des données sur les alevins en aval de Mission a montré qu'en dépit d'une corrélation avec l'effectif ultérieur du stock, ces données étaient trop variables pour servir d'outil de prévision utile.

Six modèles ont été testés et analysés dans l'optique de leur valeur pour l'estimation de l'effectif du stock en cours de saison. De façon générale, aucun modèle ne s'est montré supérieur aux autres. L'effectif des remontées estimé s'est avéré raisonnablement exact par comparaison à l'effectif final, mais on a noté plusieurs années au cours desquelles l'estimation faite en cours de saison et l'estimation finale différaient de façon significative. Les modèles actuels sont dépendants de l'hypothèse d'une période de migration moyenne des stocks de saumon kéta utilisée pour le modèle Clockwork. Les modèles d'estimation en cours de saison fondés sur le moment moyen de la migration sous-estiment ou surestiment l'effectif à cause de la variabilité du moment de la remontée. Le fait d'incorporer le rapport des sexes au modèle le plus performant pourrait permettre d'améliorer les prévisions en comparaison avec le meilleur modèle sans le rapport des sexes.

Les résultats de l'examen indiqueraient que, de façon générale, la stratégie de gestion Clockwork a donné de bons résultats et permis d'atteindre plusieurs des objectifs fixés. Plus précisément, la stratégie a permis de limiter la pêche commerciale au cours de la plupart des années, d'accroître le total des échappées de poissons sauvages et de mieux connaître les niveaux d'échappées cibles optimaux. Si l'on envisage l'ensemble des résultats et prend en compte les incertitudes connexes, la stratégie de gestion Clockwork a donné d'assez bons résultats en ce qui a trait à l'atteinte des cibles en matière d'échappées et de récolte. Elle devrait donc être maintenue. Cela dit, le dénombrement des échappées et l'exactitude de leur estimation sur lesquels reposent la stratégie Clockwork et l'examen de l'état du stock demeurent sources de préoccupations. Il y a lieu de normaliser les méthodes de collecte des données afin d'améliorer l'estimation des échappées.

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# 1.0 Introduction

Chum returning to spawn in their natal streams in the Mainland Inlets, Johnstone Strait, Strait of Georgia, and the Fraser River migrate primarily through Johnstone Strait. Because of their overlapping timing and migration route, chum from these areas are grouped into a single unit for management purposes, commonly referred to as the Inner South Coast (ISC). More than 400 distinctive populations of chum originate in the ISC. However, 45 of these populations are responsible for 85% of the chum production, with the Fraser River having the largest populations (Anderson and Beacham 1983).

The ISC is divided into fifteen major geographic regions: 1) Seymour to Belize Inlet, 2) Upper Vancouver Island, 3) Johnstone Strait, 4) Mid Vancouver Island, 5) Lower Vancouver Island, 6) South Vancouver Island, 7) Kingcome Inlet, 8) Bond to Knight inlets, 9) Loughborough to Bute inlets, 10) Toba Inlet, 11) Jervis Inlet, 12) Howe Sound/Sunshine Coast, 13) Burrard Inlet, 14) Fraser River, and 15) Boundary Bay (Figure 1.1).

A subgroup of ISC chum stocks forms the Inner Study Area or Clockwork chums. The ISA includes chum salmon stocks spawning along the east and west coasts of Johnstone and Georgia straits from the north end of Vancouver Island to Boundary Bay and Saanich Inlet to the south. The ISA does not include chum stocks in Seymour to Belize Inlet (Area 11) in the north and the southern portion of South Vancouver Island (Areas 19 and 20) because these stocks are not harvested in Johnstone or Georgia Straits.

## *1.1 The Fisheries*

ISC chum stocks are divided into two groups based on run timing, the Summer and Fall runs. Summer chum migrate in June, July and August and spawn in September and early October while Fall chum migrate in September, October and November and spawn from October to January (Salo 1991). Only the Fall run stocks are actively managed in mixed stock fisheries. The Summer run stocks are managed in terminal areas where local surpluses are harvested. The major inside Summer run stocks are in Bute and Kingcome inlets.

Chum salmon migrating through Johnstone and Georgia straits are subjected to several fisheries. The first major fishery on ISC chum stocks occurs in Johnstone Strait (Statistical Areas 12 and 13), approximately 110 km in length, through which chum must pass en route to their spawning grounds. Here chum are concentrated during their inshore migration and are subjected to intensive net fisheries (seine and gillnet). The catch in this fishery has ranged from 15% to 80% of the total commercial catch of ISC stocks between 1980 and 1996 and averaged about 60% of the commercial catch or 1.0M (million) chum per year between 1990 and 1996.

The terminal fishery at Qualicum Bay harvests predominately enhanced chum stocks from the Big Qualicum, Little Qualicum and Puntledge River hatcheries. The catch in the Qualicum fishery has ranged from 10% to 80% of the total commercial catch between 1980 and 1996 and averaged about 20% of the commercial catch or 270,000 chum per year between 1990 and 1996.

Other areas that have terminal fisheries are the Cowichan, Goldstream, Nanaimo and the Nimpkish rivers, and in Jervis and Bute inlets. These fisheries target mainly on local stocks.

The Fraser River fishery (Statistical Area 29) includes the 80 km of the Fraser River downstream from Mission, the estuary and the adjacent waters of the southern portion of Georgia Strait. The Fraser River fishery harvests predominately enhanced chum stocks from the Harrison, Chehalis, Inch, Stave, and Chilliwack/Vedder systems. Canadian chum (primarily of Fraser River origin) are also harvested in U.S. fishing areas. The commercial catches in Area 29 and the U.S. areas are of about equal magnitude and represent about 5% and 8%, respectively, of the total commercial ISC chum catch.

Chum salmon are important to aboriginal peoples for food, ceremonial, and cultural purposes. In the early 1990s, DFO initiated greater access to the salmon resource for First Nations through the Aboriginal Fisheries Strategy. This initiative resulted in greater participation by First Nation groups in ISC chum fisheries.

Historically, the recreational sports fishery has harvested very few chum salmon. The inclement weather conditions during the late return timing of chum salmon and that they are less desirable as a sports fish have contributed to the lack of interest in this species. However, the recent low abundance of coho and chinook and the development of appropriate recreational chum fishing techniques have resulted in a small but growing sports fishery for chum in Johnstone Strait.

### *1.2 Resource Status*

In the late 1800s and early 1900s chum salmon were considered a less desirable species and therefore were of less concern to the commercial fishery. Chum fisheries of British Columbia assumed commercial importance during the war of 1914 -18 (Hoar 1951). Catch statistics for a 31-year period, 1917 to 1947 shows an increase in chum catches due to the decrease in sockeye catches (as a result of the Hell's Gate slide). Declines in chum abundance were experienced in the early 1940s and it seems highly probable that total returns were low in the early 1920s and 1930s. Since 1939 the contribution of chum to the catch has steadily increased.

Catch of ISC chum stocks declined sharply between the early 1950s and the mid-1960s while escapements were stable at low levels (Figure 1.2). The rapidly declining stock size in the early 1960s prompted the complete closure of commercial chum fisheries in 1965 and 1966. The stock then rapidly recovered, so that 1973 recorded a catch of just over 3.0M chum and an escapement of nearly 1.6M. Catches again declined between 1974 and 1981, with higher catches in even-numbered years than in odd-numbered years (Beacham 1984). To address the problem of rebuilding the wild component of chum production and to provide the maximum long-term benefit to industry, a "Clockwork" management plan was implemented in 1983. In addition, major enhancement efforts commenced in the 1980s, and began to show significant returns by 1985.

### *1.3 Enhancement*

The first major Department of Fisheries and Oceans chum enhancement project was designed to increase the freshwater survival of chum salmon by building a flow control and small artificial spawning channel facility on the Big Qualicum River in 1963. This spawning channel (Channel #1) was converted into a chum rearing channel in 1966 and finally rebuilt into a coho rearing channel. A new spawning channel with a capacity of 34 million eggs was built in 1967 (Fraser et al, 1983). The Salmon Enhancement Program's (SEP) first spawning channel was built on the Little Qualicum River in 1979. It had a capacity of 75 million chum eggs.

SEP piloted the Japanese style of chum enhancement at the Thornton Creek pilot hatchery in 1976-77. A successful program at Thornton led SEP to use the Japanese style in the design of all its major chum hatcheries. The technique involves the groundwater incubation of eggs in bulk incubators usually called modified Atkins boxes or freestyle boxes. Prior to hatching, eggs are usually placed on Vexar trays above a layer of gravel or other media in shallow concrete raceways known as keeper channels. Upon hatching, fry drop through the trays into the gravel. Fry migrate directly from the keeper channels into concrete raceways for rearing. Rearing is also performed in earthen channels and seapens. By utilizing the temperature advantage of groundwater, fry can be reared for 30-40 days in freshwater to approximately 1.0-1.5 g at release at close to the normal wild migration time. This size advantage was expected to double survival compared to unfed wild fry.

Chum facilities are situated in locations where terminal fisheries can harvest enhanced chum stocks at high rates without over-harvesting non-enhanced stocks. All major Mid Vancouver Island stocks (Big Qualicum, Little Qualicum, and Puntledge) and all major Fraser River chum stocks were enhanced (Chilliwack, Chehalis, Harrison, Inch, Stave, and Alouette). All Harrison stocks including Chehalis, Harrison, and Squakum, and Weaver of various run timings were initially enhanced and releases went back their streams of origin. By 1986 releases were only made into the Chehalis River from Chehalis Hatchery. Chehalis hatchery stock originated from transplants of all of the various Harrison stocks. There are a number of other Community Involvement facilities producing chum (Powell River, Sliammon, Kanaka Cr., and Alouette) which are not included in this analysis because of limited marking.

### *1.4 Clockwork Management*

Prior to 1983 the stated management approach for ISC chum involved harvesting all chum salmon in excess of an escapement goal for all stocks combined. In practice, this approach was difficult to implement because of differences in run timing and productivity with the result that some stocks were over-harvested while other stocks were potentially under-harvested.

The Johnstone Strait Clockwork Management Strategy was implemented in 1983 (Hilborn and Luedke 1987). The primary objective of the Clockwork was to rebuild ISA wild chum stocks within 12 to 15 years to the target escapement level of 2.5M chum (including 700,000 Fraser River chum) by controlling the overall harvest rate. The plan allows for limited fishing at low stock abundance, thereby stabilizing the annual catch. Incremental harvest rates for the marine fisheries are set at 10%, 20%, 30% or 40% depending upon the run size. For fishery management planning purposes, a pre-season forecast of abundance is used to determine the expected harvest rate. The harvest rate is adjusted if in-season information suggests the pre-season forecast was incorrect.

The Clockwork allows both the catch and the escapement to increase with increasing total run size up to a maximum harvest rate of 40%. A Fraser River Clockwork management plan was implemented in 1987 (Gould et al. 1991) to provide management goals and fishing limits for the harvest of Fraser River chum, independent of the Johnstone Strait fishery.

The Clockwork has been reviewed periodically and a number of changes adopted. The changes were adopted for a variety of reasons, such as increasing enhancement levels or as a means to increase the probability of achieving the wild escapement goal at lower run sizes. Fourteen years of chum salmon returns have occurred since the Clockwork Management Strategy was implemented and it is time for an in depth review of chum stock status and management strategy. The review provides: 1) Trends in chum Clockwork stock and enhanced production; 2) Status of escapement estimates; 3) An up-date stock-recuit analysis, including the larger returns for 1997, for both the Fraser and non-Fraser Clockwork stocks and for both the wild and enhanced components; 4) The utility of the Mission fry estimates in it's relation to sebsequent returns; 5) A restrospective analysis of in-season run sizes in Johnstone Strait; and 6) A review of the fishery management, 1983 to 1997, with respect to the effectiveness of the Clockwork management strategy.

## 2.0 Data Sources

Data used in this document are estimates of annual catch from test, commercial and Native fisheries, escapement estimates from wild and enhanced systems and estimates of stock composition obtained from GSI. The following is a summary of the sources and methodology for the collection of these data. Inconsistencies or possible sources of error are noted where appropriate.

Data for the analyses was extracted from the Chum Clockwork System Database. This is a Microsoft Access Database system that contains the necessary information for clockwork chum stocks (including Fraser River stocks) that can be easily extracted in report form or as spreadsheet files for import into Microsoft Excel for analysis or further export.

Data from Area 11 (Seymour and Belize Inlets) and Areas 19 and 20 (Southern Vancouver Island) and for Summer chum were not included in the analyses relating to Study Area or Clockwork Chum. Escapement data from these areas was included in the Stock Status Review for completeness.

## 2.1 Catch

Estimates of ISC chum catch are made for Canadian and U.S. commercial fisheries as well as Native fisheries. The catch of sport caught chum is considered insignificant but has been increasing in recent years.

Canadian commercial and test fishery catches are from sale slip records. All Canadian commercial catches were obtained from the Commercial Salmon Catch Database maintained at the Pacific Biological Station. U.S. commercial catches are from the Washington Department of Fisheries/Tribal Catch Database. Estimates of Canadian Native food and commercial catches are from British Columbia Catch Statistics, Bijsterveld and James (1986) and MacDonald (1987).

## 2.2 Escapement

Estimates of total escapement can be divided into two components; fish spawning in naturally occurring or rehabilitated spawning grounds and fish returning to a hatchery facility. Official escapement estimates (spawning counts and hatchery returns (BC16's)) for chum salmon streams have been recorded since 1953 and are available in the SEDS computer database at the Pacific Biological Station. There are numerous exceptions, especially in recent years, where an alternative data source has been used, as there is no BC16 report. Additional data was obtained from local fisheries offices, Fraser River Action Plan, Fisheries Management Group (DFO 1996) and SEP escapement data files.

## 2.3 Target escapement and spawning capacity levels

The Pacific Region Salmon Stock Management Plan (DFO 1988) contains target escapement levels for the major regions within the Inner South Coast. A historical review of chum salmon data for the years prior to 1985 by the Pacific Salmon Commission Joint Chum Technical Committee (1988) contain estimates of spawning capacity for Inside Study Area chum stocks associated with the chum Clockwork Management Strategy.

## 2.4 Enhancement Contribution

Enhanced contributions from major facilities is based on marking a portion of the fry released with an adipose clip and coded-wire tag (Ad-cwt) or a ventral fin-clip with or without an adipose clip (MFC), and recovery of these marks in the commercial fishery and escapement. Marked fry are enumerated individually at marking. Big and Little Qualicum and the Chilliwack releases have been marked with finclips and Puntledge, Chehalis, Inch, and Chehalis with Ad-cwt's. Unmarked fry represented by the mark are enumerated by subtracting egg and fry mortalities from the egg number which is usually calculated using electronic egg counters. Since egg and fry mortality generally is less than 10%, fry enumeration is considered to be very accurate. Not all release groups are represented by a mark. Contributions for those groups are estimated by associating them with a marked release group with a similar size and release timing. Unfed unmarked release groups were usually given half the survival of an associated fed release group. All chum release data is maintained in the Mark Recovery Program (MRP) database on the VAX at the Pacific Biological Station. Kuhn et al, 1988 (P. 6-10) describes the release data in detail.

Sampling of the commercial net catch has been carried out in specific catch areas under contract to the Stock Assessment Division, Mark Recovery Program. Sampling of the ISC catch usually occurs at processors in Vancouver. The catch is usually sampled on conveyor belts as the packers are unloaded. No sampling is performed on troll, sport, native, or U.S. catches. Troll and sport catches are estimated to be less than 2% of the total catch. Catches by native and U.S. fishers can be considerable, especially for Fraser stocks. From 1985-1997 this would add an estimated 35% to enhanced catch and 10% to total enhanced Fraser stock. Not all weeks or areas were sampled consistently. For some unsampled weeks the mark rate from the previous or subsequent week was used to estimate contribution. Contributions are considered to be a minimum estimate of total enhanced contribution.

Except for Chehalis natural spawners, SEP escapement data is considered quite reliable. Big Qualicum counts 95% of the chum through a fence and samples all fish in the spawning channel and a portion of the river. All chum migrating into the Little Qualicum spawning channel have been regularly enumerated and sampled for marks; the river is visually enumerated and sampled for marks. All other enhanced stocks, except the Stave River, have an extensive migration (rack) into the facilities and these are accurately counted and intensively sampled. In addition, these facilities also estimate escapement and sample for marks on the spawning grounds. Puntledge Hatchery conducts a regular visual enumeration, brood stock collection, and dead pitch on the river. Tag and recovery programs have occurred in 1989-91, 94 on the Stave River and in 1986,1996, and 1997 on the Chilliwack River. In subsequent years the Stave River has been enumerated weekly by helicopter and AUC (Area-Under-the-Curve) estimates are made to estimate escapement. Extensive dead pitches have occurred on the Stave for mark sampling. Chilliwack estimates escapement by using the dead pitch recovery rate from the 1986 tag and recovery program and a comparable effort dead pitch in subsequent years adjusted for water conditions. Chehalis Hatchery does a visual escapement estimate on the Chehalis River. Inch Hatchery conducts a below the fence dead pitch which recovers at least 90 % of the spawned chums in this groundwater fed stream. More detailed data on escapement enumeration is located in PSARC report S90-11. Rack returns may be used for broodstock or be subject to ESSR (Escapement Surplus to Spawning Requirements) and sold to the highest bidder or supplied to the local native community for subsequent sale. These rack returns are not included in the exploitation rate computed here but are included in the escapement.

Up to and including the 1994 return year, contributions had been calculated on Apple Magicalc and IBM Framework spreadsheets, some of which had been converted to Excel. Summaries of this data were included in an interim chum Microsoft Access SEP Evaluation database. A new Access database currently calculates catch and escapement contributions from the 1995 return year but summaries of the previous data are also maintained in this database. Catch contributions for 1997 have not been added to the database, the data is from preliminary in-season Excel spreadsheets. Escapement contributions for 1997 are included for all facilities except Puntledge. Contributions are adjusted upwards for an estimated 30% mark mortality based on years of extensive sampling at Big Qualicum where all fry migrants were enumerated and mark returns were extensively sampled. This estimate of mark mortality was confirmed from a 1989 brood release of marked chum into Cook Creek, a barren stream on the West Coast of Vancouver Island, (D.Bailey, unpublished data). More detailed information on how these contributions are calculated are contained in previous PSARC reports S88-11 (Bailey and Plotnikoff, 1988), S89-24 (Bailey and Plotkikoff, 1989), and S90-11 (Bailey et al. 1990).

### *2.5 Stock Identification*

Estimates of Fraser River and Canadian non-Fraser stock groups were estimated through the use of GSI methods (Hop Wo et al., 1991). GSI samples have been collected from 1982 through 1993, and 1996 in all major intercepting fisheries. For years without samples estimates of Fraser River/Canadian non-Fraser River contribution were estimated by weekly average GSI data for each intercepting fishery. Chum salmon caught in the Fraser River terminal fishery are assumed to be 100% Fraser River origin. Since 1980, all Fraser River terminal fisheries targeting on chum salmon have occurred in the River portion of Area 29.

Calculation of the Fraser River portion in U.S. fisheries is made using fixed percentages of 32% for U.S. Areas 4B, 5 6C, 56% Areas 7 and 90% Area 7A. These estimates were based upon previous tagging studies. GSI sampling supports the averages.

### *2.6 Age*

Fish scales used to determine age structure are derived from catch (commercial and test fisheries) and escapement samples. Fish age was determined from annular ring counts. For example, a chum salmon scale with three angular rings would be classified as a 4-year old fish. In the European system this fish would be designated as a 0.3.

### *2.7 Effort*

Effort information is recorded as boat days for commercial fisheries and number of sets for the test fisheries. Effort counts were obtained visually via overflights during the operation of the commercial fishery.

### *2.8 Test Fisheries*

The final primary source of data used in this report was obtained from two seine vessels operating under charter to DFO within Johnstone Strait. The program was initiated in 1965, primarily in years of low expected abundance. Starting in the late 1970's the program has begun in late September and continued through until early November. Each vessel is required to make six test sets per day among 40 possible locations within Johnstone Strait. Full descriptions of this operation can be found in Hop Wo et al. (1993) and are not repeated here.

# 3.0 Trends in Chum Clockwork Stock and Enhanced Production

## *3.1 Enhanced juvenile releases*

Figure 3.1 and Table 3.1 shows the estimated ISC fed (mostly Fraser hatcheries) and unfed (mostly Non-Fraser flow control and spawning channel) chum releases from major enhancement facilities. As new SEP facilities came online from 1980-1983 in the Fraser, the number of fed releases increased almost five times from an average of 6.9 million in the 1978-81 broods to 33.4 million in the 1982-86 broods. Unfed fry releases increased more slowly from an average of 55.1 million for the 1980-83 broods to 65.1 million for the 1982-86 broods. However, poor escapements in 1995 through 1997 to Big and Little Qualicum dramatically reduced unfed fry releases. In 1985, the Fraser River fishery management group asked SEP to concentrate chum enhancement on the mid-timing Fraser component. As a result of adopting this strategy, the Chehalis Hatchery could not double use its ponds for rearing. Fry production was reduced from an original target of 13.0 million fry to 7.8 million fry. Inch and Chilliwack have subsequently reduced fed fry production because of higher priorities for chinook. Fed fry production was reduced from an average 33.4 million for 1982-86 broods to 24.1 million for 1987-97. The latest fed fry target of 15.6 million is only 46% of the original target of 28.8 million. Unfed fry release targets have remained largely the same. Because of these fed fry reductions, enhanced contribution to the Fraser River has not been as high as originally intended and should continue to decrease as progeny from the current targets return. Inside Non-Fraser chum production should remain stable.

## *3.2 Enhanced contribution to Canadian net catch and escapement*

Tables 3.2.1 to 3.2.3 show the estimated contribution of major SEP facilities to the net catch, escapement, and total stock from the 1980 return year to 1997. Data for 1997 are preliminary. Catches have averaged about 575,000 for ISC stocks from 1985-94 return years (when facilities were in full operation) of which most originated from the Non-Fraser stocks (473,000-82%) compared to Fraser stocks (102,000-18%). This is the result of the much higher Non-Fraser releases and a higher exploitation rate as a result of the Area 14 terminal fishery. Poor survivals in the 1995-97 return years dramatically reduced catches. Escapements during the same 1985-94 time period have averaged 396,000 for the ISC stocks and 209,000 (53%) for Non-Fraser stocks versus 187,000 (47%) for Fraser stocks. Escapements decreased 40% for the 1995-97 return years. Total enhanced stock for the 1985-94 time period has averaged 971,000 for the ISC stocks of which 681,000 (70%) are from Non-Fraser stocks and 290,000 (30%) from Fraser stocks. This decreased to 120,000 for Non-Fraser stocks and 148,000 for Fraser stocks for the 1995-97 return years. Concerns about the trend to lower production for the 1995-97 return year were somewhat allayed with the near record chum returns in 1998.

Figure 3.2.1 and Table 3.2.4 shows the prevalence of enhanced fish in the catch and escapement for Non-Fraser and Fraser stocks. For the 1980-97 return years 33% of the average catch and 19% of the average escapement for the Non-Fraser stocks were estimated to be of enhanced origin. This rises to 38% and 21% for 1985-94 when enhanced stocks were most prevalent. The enhanced contribution in the catch is higher than the escapement because of the concentration of the Johnstone Strait harvest on mid-timing enhanced stocks and the fact that the terminal Area 14 fishery only targets enhanced stocks. Comparable numbers for the Fraser stocks were 23% of the catch and 15% of the escapement for 1980-97 and 34% and 22% for 1985-94. Catch numbers are likely higher because of the concentration of harvest in Johnstone Strait and the Fraser River on mid-timing enhanced stocks. Reductions of the enhanced proportion in the 1995-97 Non-Fraser catch are probably due to the drastically reduced harvest in those years, particularly in time periods and terminal areas where enhanced fish are usually present. The reduced enhanced proportion in the 1995-97 Fraser escapement is directly correlated with the large increase in Harrison wild escapements which increased from an average of 124,000 in 1980-89 to 825,000 in 1994 and 1,256,000 in 1995 subsequently dropping to 496,000 in 1996.

Significant numbers of enhanced origin chum spawn naturally. Table 3.2.5 gives some indication of the numbers in recent years. Unfortunately the data is not electronically available prior to 1992. The data shows that significant numbers spawn naturally and have over the years contributed substantially to rebuilding depressed chum escapements, especially in streams like the Stave where all returning chum spawn naturally.

## *3.3 Enhanced exploitation rates*

Table 3.3.1 shows the enhanced stocks net catch exploitation rate, which has averaged 57% for the 1985-94 return years. Non-Fraser stocks have a substantially higher exploitation rate at 67% versus 32% for Fraser stocks. The Non-Fraser enhanced exploitation rate is higher than the overall Non-Fraser wild + enhanced rate of 54% because harvest is generally concentrated on the more productive mid timing enhanced stocks in Johnstone Strait and because the terminal fishery in Area 14 is concentrated only on enhanced stocks. Addition of enhanced contribution to U.S., sport, and native catches would probably increase the Fraser enhanced exploitation rate from 32% to about 43%. This is higher than the enhanced + wild exploitation rate of 32% probably because harvest is concentrated on the mid timing enhanced stocks rather than the late timing wild stocks. Exploitation rates dropped to low levels in 1995-97 return years, reflecting poor returns of both wild and enhanced stocks.

The exploitation rates of among Non-Fraser facilities are similar but Puntledge and L.Qualicum are slightly lower than Big Qualicum, probably because of earlier timing than Big Qualicum. Terminal harvests tended to occur after escapement targets were attained. Fraser facility exploitation rates are similar except for Stave and Inch whose timings are earlier and later respectively than other enhanced stocks.

Table 3.3.2 shows the distribution of enhanced chum to the catch and escapement recovery areas. For the 1980-97 return years Non-Fraser enhanced stocks have averaged 20% harvest in

Johnstone Strait plus a terminal harvest of 32% in Area 14. This increases to 30% and 36% respectively for the 1985-94 returns years when enhanced fish were most prevalent and stocks were strong. Because most of the Non-Fraser enhanced releases were marked with the same fin-clips as those used at enhancement facilities on the outside of Vancouver Island and in the North, any Non-Fraser stocks caught in Area 2-10, 21-27 could not be identified. For the 1980-97 return years Fraser enhanced stocks were harvested at a rate of 17% in Johnstone Strait, 3% in Area 14-20, and 5% in Area 29 fisheries. For the 1985-94 return years this increases to 24%, 2%, and 6% respectively. A small number were harvested outside of these areas. Chehalis, Inch, and Stave were coded-wire tagged and tags have been recovered at low rates (< 1%) during sampling in the Nitinat (Area 21) and Conuma (Area 25) fisheries. Some have also been recovered in Ad-cwt sampling in Alaska and Northern B.C., although in very low numbers.

### *3.4 Enhanced fry-to-adult survivals*

Figure 3.4.1 and Table 3.4.1 shows the fry-to-adult survivals for enhanced fed and unfed releases from ISC chum. Survivals of fed fry from Non-Fraser facilities have generally been slightly higher than from Fraser facilities. If estimated contributions from U.S. and native catches are added to the Fraser survivals, survivals would likely be about 10% higher at about 1.2 %, putting them in the same range as the Non-Fraser facilities. This is still lower than the target survival of 1.5% which is based on a doubling of unfed survival. Unfed fry survivals have averaged 0.70% for Big Qualicum and 0.47% for Little Qualicum for the 1978-92 broods. Why survival is different between these two stocks is presently unknown. Big Qualicum survival is based on releases from the river as well as the spawning channel while Little Qualicum is based only on spawning channel releases, but previous data at Big Qualicum showed no difference in survival between Big Qualicum channel and river releases (Fraser et al. 1983). The previous 1959-77 brood average Big Qualicum unfed survival was 0.50%, substantially less than the subsequent average survival.

Annual survival is extremely variable ranging from a low of 0.29 % to a high of 2.69% for Fraser fed fry and a low of 0.03% to a high of 1.17% for Non-Fraser unfed fry. Coupled with the variability in freshwater survival for wild stocks this variability makes forecasting chum returns very difficult.

Competition with Fraser pinks may be a factor in survival of enhanced Fraser chum fry. Every Fraser enhanced chum stock has a higher average survival in the even years when pinks are not present than in the odd years. For the Fraser enhanced stock in total, average survival in the odd years was 0.88 % compared to 1.38% in the even years, a reduction of 36%. Beacham and Starr 1982 estimated an average survival of .85% for the 1961-74 broods of Fraser wild chum in the odd years compared to 1.53% in the even years, a reduction of 44%.

### *3.5 Enhanced age composition*

Table 3.5.1 shows the age composition of enhanced chum for the 1977 to 1991 brood years. This is based on the finclip scale age or the cwt age of returning marked enhanced chum. Average age composition for catch plus escapement for the 1981-90 broods when most of the enhanced stocks were present was estimated at 11% Age 3, 72% Age 4, and 17% Age 5 for the Non-Fraser stocks and 14% Age 3, 76% Age 4, and 10% Age 5 for Fraser stocks. The slightly earlier age at return for Fraser stocks may be related to rearing of Fraser chum. Age composition in the catch is slightly biased toward older ages.

Table 3.5.2 compares the 1981-90 brood average age composition of marked enhanced stocks with the average age composition of scale aged chum sampled in fishery catches. The data is very similar except for enhanced Fraser stocks that seem to return at a slightly earlier age.

### *3.6 Summary*

Chum enhancement increased dramatically on the Inside South Coast in the early 1980's with the building of three major Japanese-style chum facilities on the Fraser (Chilliwack, Chehalis, and Inch) and a chum hatchery (Puntledge) and spawning channel (Little Qualicum) on mid Vancouver Island. Fed fry production peaked at 33.4 million fed chum fry for the 1982-86 broods. Current fed fry production targets are 15.6 million fed fry. Unfed fry targets have not changed dramatically and are currently at 84.9 million. Actual releases have averaged 70.7 million unfed fry since 1987. Enhanced contribution based on an analysis of mark returns between 1985 and 1997 has averaged 449,000 in the catch and 360,000 in the escapement. This represents 38% of the average catch and 19% of the average escapement for this time period. A substantial number of the enhanced escapement has spawned naturally, thus helping to rebuild natural runs especially in the Fraser. Overall enhanced exploitation rates during this time period have averaged 54% for the Non-Fraser and 27 % for the Fraser. Addition of the enhanced contribution from the U.S., sport, and native catches would probably increase the Fraser exploitation rate to about 36%. These exploitation rates are higher than for wild + enhanced returns because of a concentration of harvest on enhanced mid timing stocks in the mixed stock fisheries as well as a terminal fishery in mid Vancouver Island on only enhanced stocks. Enhanced fry-to-adult survivals have averaged 1.26 % for Non-Fraser and 1.2% for the Fraser (adjusted for U.S. and native catches) which is slightly below the target of 1.5%. Survival of odd-year Fraser enhanced broods are an estimated 36% below even year survival possibly because of competition with Fraser pinks. Age composition from scale aged and cwt aged marks of enhanced stocks for the 1981-90 broods averaged 13.0% Age 3, 72.6% Age 4, 14.1% Age 5, and 0.3% Age 6.

## 4.0 Status of Inner South Coast Escapement Estimates

Estimating escapement for chum salmon is only one of several requirements for the operation of the Clockwork approach to chum stock assessments. A review of the adequacy of our escapement enumeration system is necessary if the Region is to seriously develop accurate assessments of chum salmon productivity and to use the Clockwork approach to manage Inner South Coast chum salmon.

### *4.1 Methods*

The escapement estimates for each geographic region within the Inner South Coast area were plotted for each year. The target escapement and spawning capacity levels were included to show escapement trends relative to the escapement targets and spawning capacity levels.

The inherent high variability in escapements due to natural annual fluctuations, but in particular, the confounding effects of inconsistent enumeration procedures prevent rigorous statistical testing.

To compare trends between areas of different size and escapement magnitude all escapement data were standardized:

$$Z = \frac{X_I - X}{SD}$$

| | | | |
|---|---|---|---|
| Where | $Z$ | = | the standard score (i.e. mean =0), |
| | $X_I$ | = | an original escapement value, |
| | $X$ | = | the mean of all recorded escapements for each area or aggregate, |
| | SD | = | standard deviation of all recorded escapements for each area or aggregate |

To reduce the effect of changes in observers over time and their unknown level of thoroughness in enumeration spawners and because escapement estimates are obtained by different procedures during some years (i.e. fence counts, mark-recapture visual observations during stream walk and over flights), raw escapement time series data were smoothed using a procedure introduced by Cleveland (1985). Lowess (locally weighted regression) data smoothing was applied to the escapement time series. A “locally weighted” linear regression is used to obtain smoothed values for each value of y, given the values for x. That is, for each $x_i$, a linear regression is computed in which nearby values are weighted more heavily than values further away. Then the estimated regression coefficients are used to predict a smoothed value for $y_i$, given $x_i$. ). The procedure is particularly suitable for assessing trends in escapement because it takes into account unequal spacing between years (i.e. missing escapement records) and produces a smoothed function which is not sensitive to outliers. Escapement data typically contains numerous missing values and unexplained outliers. The lowess-smoothed curves were used to clarify the relationships between the escapement estimates and years. Using the standardized and smoothed escapements as a measure of relative abundance, each geographic area or aggregate was examine for years with obvious deflections in escapement from the grand mean (the zero line).

## 4.2 Escapement Surveys

Most chum escapement estimates are based on visual counts by field staff, exceptions to this being counts at fences or adult tagging programs. Fence counts and tagging programs have been largely limited to large chum salmon stocks that have been enhanced (Big Qualicum and Harrison/Chehalis). Visual estimates are not considered to be accurate estimates of spawning numbers but are treated as indices of trends in escapement (Shardlow et al. 1987). Even then the consistency of these indices among streams and years is uncertain but trends in escapement do reflect trends in catch or test fishing data when these data have been compared. If escapement surveys were consistent in methods and number of streams surveyed each year then assessment studies could express production as the number of chum produced per index spawner, without making assumptions about the accuracy of an escapement estimate.

Average escapement estimates by decade from 1953 to 1997 for systems with at least one chum salmon record and by stock group are presented in Table 4.1. Most of the escapements were estimated by conducting walking surveys, aerial surveys, or float surveys. Although visual surveys produce the least precise and least accurate estimates of absolute escapement, such estimates are the only consistent historical measure of stock status available. Thus escapement trends are considered a relative measure of abundance.

There is concern regarding the inconsistencies in methodologies and the lack of effort directed to escapement enumeration. The methodology for most small (<10,000 spawners) is accomplished by walking the stream and counting the spawners. The methodology for larger systems has varied through time and has included aerial overflights, mark recapture programs, dead pitch surveys, and river floats. In some years there are no field observations or enumeration programs on some individual systems. In some areas there are no observations at all. Figure 4.1 presents a review of the enumeration effort for ISC escapement surveys. Only 27 or 6 % of the 423 chum stocks in the ISC have complete spawning escapement records from 1953 to 1997 and 129 or 36 % of the chum stocks have from 30 to 44 years of escapement estimates. Most chum stocks (209 or 52%) have less than 18 years of observations. From 1953 to 1983 approximately 50% of the 423 chum stocks in the ISC were surveyed each year (Figure 4.2). Effort increased and peaked in 1985 at 65% of the systems being surveyed. Since 1985 the effort has declined to less than 40% of the systems being surveyed each year.

Changes have also occurred in the proportion of escapement contributed by each system to the total escapement (Table 4.3 and Figure 4.3). There has been a steady decrease in the number of stocks required to achieve 85% of the total escapement. Fifty stocks accounted for 85% of the total escapement in the 1950s, 34 in the 1960s, 33 in the 1970s, 28 in the 1980s, and 16 in the 1990s. In the 1990s the Harrison, Stave, and Chilliwack rivers have accounted for 46% of the total escapement to the ISC. These are Fraser River stocks and all have some level of enhancement.

In 1997, a select number of chum streams were independently enumerated using an index section of stream (1000 m), weekly visits and area under the curve analysis methodology. The person responsible for producing the BC16 for the selected streams produced independent escapement estimates using traditional stream enumeration techniques for the SEDS database. On average the estimates obtained by the weekly visual estimates and area under the curve analysis are higher than those reported in the SEDS database (Table 4.4). Increased effort and standardized methodology improved the estimates even though the whole stream was not necessarily surveyed. The 1997 AUC estimates are probably under-estimates because the program terminated for most areas stopped on October 31 prior to the completion of chum spawning in most systems.

## *4.3 Escapement Targets*

Escapement targets or the desired number of spawners for each chum stock have most commonly assumed that production is proportional to spawning area (up to some limit of spawners per unit area). Field staff assesses, usually quantitatively, the spawning habitat used by chum in each stream and extrapolate to a goal based on the habitat used by the number of chum spawners they have observed. Other procedures used to set targets, such as a habitat model assuming a constant number of spawners per unit of habitat, make the same proportionality assumptions.

### Quantitative Assessment

The first reported attempt to develop escapement targets for chum salmon runs in the ISC was in 1962. As an interim measure the highest recorded escapements to individual streams during the period 1949 to 1961 were determined and then added together to provide a total escapement target of 2.3 million fish for the entire area. Since that time there have been modifications to the targets for individual sub-areas to the current total of 3.3 million fish (Table 4.3). Most estimates are based on the judgement of people familiar with the spawning area and the rationales for modifications have generally not been well documented.

### Stock-Recruitment Analysis

Relatively few target escapement levels have been set based on optimization of adult returns per spawner (stock-recruit theory). Stock-recruit functions are determined over the range of escapements observed and cannot estimate the “true” optimum escapement level unless escapements are allowed to vary from small to very large values periodically. The absence of catch estimates by individual spawning populations or regions (except the Fraser) precludes separate evaluations for individual populations or for most regions within the ISC.

Pearse (1982), on the basis of a stock-recruitment analysis suggested an escapement goal of 1.6 million chum salmon spawners for the ISC. Beacham (1984), in a stock-recruitment analysis of the ISC chum stocks suggested an optimum escapement of 2.9 million chum salmon. He also suggested that optimum escapements may be lower in odd-numbered years than those in even-numbered years, presumably as a result of competitive interactions with pink salmon.

Pearse (1982) suggested a target of 1.0 million chum salmon for the Fraser River but with a wide range from 600 thousand to 3.0 million fish. The large uncertainty is reflected of the relatively narrow range of observed spawners used in the analysis with only one-year when escapements were in excess of 600 thousand fish. A stock-recruitment analysis by Joyce and Cass (1992) indicated that the total wild return of Fraser chum from 1951 to 1991 did not decline with increasing levels of escapement achieved during the same period. Furthermore, the analysis suggested that density-dependent effects on the production of Fraser chum could not be evaluated until the spawning population exceeded 800,000. In 1985, a record high escapement of over 1.1 million chum spawners was recorded. Unfortunately, due to severe winter conditions during 1985-1986 and the resulting unusually high freshwater mortality (independent of density-dependent effects), this production was not carried forward and subsequent returns from this brood-year could not be included in the analysis. More data points at escapement levels of 800,000 spawners or higher are required in order to determine the optimal escapement and harvest levels for Fraser chum. Nevertheless, the data suggest that the optimum overall escapement level for Fraser chum salmon is likely greater than 800,000 spawners, and that the potential exists for rebuilding the Fraser chum stocks to higher levels than at present. Returns from the relatively large escapements in recent years, including the record escapements of nearly 1.5 million fish in 1995 and 1996, should help to establish a realistic escapement goal for the Fraser River in the future.

**Habitat Capacity Analysis**

There has been limited assessment of habitat capacity for chum salmon spawning in the Inner South Coast. During the early 1960s Palmer (1972) estimated the capacity of several major Fraser River chum-spawning areas based on available spawning area. During the summers of 1969 and 1970, chum producing streams on the east coast of Vancouver Island were surveyed and estimates made for chum spawning capacity (Fraser et al 1974). In 1997, a project was funded under the Pacific Salmon Revitalization Strategy - Habitat Restoration and Enhancement Program to develop and evaluate the use of standard index streams for chum salmon adult enumeration in Areas 11, 12 and 13. The project estimated the capacity of chum spawning for the index streams based on available spawning gravel.

Table 4.5 summarizes available habitat capacity information and target escapements for selective streams within the Inner South Coast. For 44% of the systems in Table 4.5 the habitat capacity estimates provide greater optimum escapement estimates than the target escapements established in 1986. This would suggest that the target estimates are below the optimum spawning capacity for these systems. Conversely, for 50% of the systems the target escapements provide greater optimum escapement estimates than the habitat capacity estimates. In cases where chum habitat spawning capacity estimates have been compared to maximum escapement levels (as indicated by existing target escapements or recent visual estimates) the habitat spawning capacity estimates are considered to be under-estimates of chum spawning capacities (Pearse 1982, Joyce and Cass 1992). This would indicate that habitat spawning capacity estimates indicate the minimum target escapement levels. However, all the estimates are questionable and may not reflect the optimum escapements for any given system. Methods for determining targets escapements are not well documented and are generally based on visual observations or mark recapture estimates that contain inherent biases. The habitat estimates are based on spawning gravel estimates and for the most part these have not been assessed in recent years. Logging activity and urban development have probably resulted in changes to chum spawning habitat in recent years and the estimates should be evaluated. Recent habitat surveys conducted by HRSEP and FsRBC may be a source of new spawning gravel estimates for a majority of streams in the ISC.

### *4.4 Status of ISC Chum Salmon*

Estimates for total, wild and enhanced escapement by system are presented in Table 4.1. Trends in total escapement for the major management regions within the Inner South Coast are presented in Figures 4.4. Summer chum and chum stocks in Seymour and Belize Inlets and those in Areas 19 and 20 of the Southern Vancouver Island group are not included in the Clockwork Management Strategy.

**Fall Chum Stocks**

There are 421 fall chum stocks with at least one observation recorded in the SEDS database for the ISC. The productivity of chum salmon stocks from these areas is influenced by numerous development activities such as forestry, agriculture, transportation, hydroelectric generation, industry and urban settlement, and ocean survival, all of which have occurred with varying intensity.

Between 1953 and 1997, the estimated total wild escapement for fall chum salmon averaged 1,191,000 with a range from 327,000 in 1995 to 2,627,000 in 1994. The average escapement to the area was 884,000 in the 1950s, declined to 772,000 in the 1960s, and increased to 1,091,000 in the 1970s to 1,807,000 in the 1990s. The escapement target for the ISC is 3,235,100 chum salmon spawners.

Total returns of ISC chum were reduced to low levels during the 1950s and 1960s primarily due to high exploitation rates (Figure 4.4). To address this problem, exploitation rates were drastically reduced in the 1960s, and a "Clockwork" management plan was implemented in 1983. In addition, major enhancement efforts commenced in the early 1980s, and began to show significant returns by 1985. Total returns to the ISC have increased since the mid-1980s (Figure 4.4).

**Summer Chum Stocks**

Summer chum salmon stocks are passively managed and are incidentally harvested in the Johnstone Strait fishery directed at Fraser River sockeye and pink salmon. The major summer chum stocks occur in the Ahnuhati and Orford rivers. Ahnuhati River summer chum salmon migrate up Knight Inlet from early July, and peak arrival in the river is in late July. The Orford River in Bute Inlet supports both summer and fall runs of chum salmon. The summer run migrates through Johnstone Strait, Sunderland Channel and Chancellor Channel from mid- to late August.

Between 1953 and 1997, the estimated total wild escapement for summer chum salmon averaged 35,400 with a range from 160,000 in 1986 to 1,030 in 1991. Summer chum returns increased from about 13,000 in the 1960s to 50,000 in the 1970s and 1980s. Summer chum stocks have declined since the late 1980s (Figure 4.4). The combined target escapement for the Ahnuhati and Orford summer chum runs is 130,000. A chum spawning channel was constructed in the early 1990s on the Orford River to enhance the summer chum run, but has failed to stabilize or increase run size because of siltation problems. Returns of summer chum have continued to decline.

**Seymour/ Belize Inlets**

Seymour/ Belize Inlet area includes Statistical Area 11. The chum stocks in this area are passively managed. The three key indicator systems are the Seymour, Waump and Taaltz rivers. The total escapement for the 19 chum stocks in the area averaged less than 22,000 spawners from 1953 to 1997 (Table 4.1). Escapements for these stocks were relatively consistent from the 1950s to the 1970s, averaging 20,000 to 30,000 chum spawners (Figure 4.4). However, during the 1980s and 1990s, chum escapements have decreased to an average of 13,000, which are about 7% of the 165,000 target escapement.

**Upper Vancouver Island**

The area extends from the Stranby drainage on the northern end of the island to the Cluxewe drainage and encompasses the northern half of Statistical Area 12.

There are 8 passively managed chum populations in the Upper Vancouver Island area. In terms of total production, the most significant stocks are from the Quatse, Keogh, and Cluxewe rivers. During the period from 1953 to 1997, the area's average escapement was 6,200 chum salmon (Table 4.1). Escapement records indicate that chum escapements to the Upper Vancouver Island are steadily declining (Figure 4.4). The average escapement was 23,000 during the 1950s and declined to 9,000 and 1,500 during the 1960s and 70s, receptively. Escapements have declined further in the 1980s and 90s, averaging less than 500 chum or less than 1% of the target escapement. The target escapement for the area is 67,000 chum salmon.

**Kingcome Inlet**

There are 16 passively managed chum stocks in the Kingcome Inlet area. Escapement records indicate that these stocks have declined from an average of 36,000 in the 1950s to 18,000 in the 1960s, 40,000 in the 1970s, and 10,000 in the 1980s (Table 4.1). Recent escapements (1990-1997) have averaged 1,900, which is less than 0.01% of the target escapement of 200,000 for this area. Escapement estimates have steadily declined since 1980 (Figure 4.4).

**Bond/Knight Inlets**

There are 24 chum stocks in the Bond/Knight Inlets. Average escapements have declined from 131,000 in the 1950s to 47,000 in the 1980s. In past years, Viner Sound Creek has accounted for 65% of the total chum escapement for the area and has averaged escapement in the order of

25,000 to 50,000 spawners during 1953-1989. The Viner Sound Creek supports both an early and a late run of fall chum. The early run, which is the main chum stock, arrives in the river from late September to mid October. The later run arrives near the end of October. During the 1990s, average escapements have dropped to 10,000 for the area and 4,600 for Viner Sound chum salmon. The target escapement for the area is 346,000 chum salmon. Escapement estimates show a marked decline throughout the time series (Figure 4.4).

**Johnstone Strait**

The Johnstone Strait area encompasses the southern half of Statistical Area 12 and most of Area 13 on Vancouver Island. It includes streams between Port McNeill and Campbell River from the Nimpkish River in the north to Mohun Creek in the south.

In the Johnstone Strait area there is one actively managed and 13 passively managed chum stocks. The Nimpkish River is the actively managed stock and has contributed more than 75% of the chum escapement to the area. The average escapement to the area was 61,000 in the 1950s, declined to 18,000 in the 1970s, increased to 48,000 in the 1980s and has increased to 72,000 in the 1990s (Table 4.1). The target escapement is 190,000 spawners for the Johnstone Strait area.

**Loughborough/Bute Inlets**

This area includes the mainland and island portions of Statistical Area 13 and Ramsay Arm and Port Neville in Area 12.

There are three actively managed (Orford, Homathko, and Southgate) and 32 passively managed chum stocks in the Loughborough/Bute area. The Orford River supports both summer and fall runs of chum salmon. The migration timing of the other chum stocks from the Loughborough/Bute area is similar to that of other fall runs on the south coast, September through November. The total chum escapement for fall runs was 49,000 in the 1950s; 35,000 in the 1960s; 97,000 in the 1970s; and 150,000 in the 1980s. Escapement estimates have generally declined since the mid-1980s (Figure 4.4). The target escapement for the area is 437,000 chum.

**Mid Vancouver Island**

The area from Campbell River to Nanoose Bay is considered the Mid Vancouver Island area. It includes the lower portion of Statistical Area 13 and all of Area 14.

There are 33 chum stocks in the Mid Vancouver Island area. The three actively managed stocks, Big and Little Qualicum and the Puntledge rivers, accounted for about 90% of the total escapement during the 1980s. Although these three systems are currently enhanced, they have historically accounted for the majority of chum escapement to the area. Escapements to these systems represent about 70%, 85%, and 90% of total escapement during the 1950s, 1960s and 1970s, respectively. Total escapements to the area have increased from 130,000 chum in the

1950s to 150,000 in the 1990s. The total wild target escapement for the area is 239,500 chum. The time series trend for MVI stocks has increased since 1965 (Figure 4.4).

**Toba Inlet**

The Toba Inlet area includes all of Statistical Area 15 and Ramsey Arm in Area 13.

There are 15 systems in Toba Inlet that support chum salmon. Only the Okeover and Toba River stocks are actively managed. In the 1980s these stocks accounted for 60% of the total chum escapement to the area. Total escapement averaged 52,000 in the 1950s and declined to 21,000 in the 1960s, 16,000 in the 1970s, 10,000 in the 1980s, and 740 in the early 1990s. Escapement enumeration effort has also decline in Toba Inlet with less than 4 systems surveyed each year since 1989. The target escapement is 180,000 chum salmon. Escapement estimates show a marked decline throughout the time series (Figure 4.4).

**Jervis Inlet**

The Jervis Inlet area includes all of Statistical Area 16.

There are 36 streams in Jervis Inlet that support chum salmon populations. The five actively managed stocks (Deserted, Pender Harbour, Saltery Bay, Sliammon, and Tzoonie) account for more than 70% of the total escapement. Chum returns have ranged from 56,000 to 96,000 in previous decades to an average of 108,000 during the 1990s. The target escapement is 140,100 chum salmon.

**Lower Vancouver Island**

The Lower Vancouver Island area is located between Nanoose Bay and Crofton and includes Statistical Area 17.

There are 18 streams in the Lower Vancouver Island area that support chum salmon populations. Of the Lower Vancouver Island chum stocks, only the Nanaimo is actively managed. This stock accounted for 75% of the total escapement to the area from 1953 to 1997. Average escapements to the area were 68,000 in the 1950s, declined to 32,000 in the 1960s, increased to 54,000 in the 1970s and 65,000 in the 1980s and 1990s. The target escapement is 134,000 chum salmon.

**Southern Vancouver Island**

Southern Vancouver Island refers to the area from Crofton and east of Port Renfrew and includes Statistical Areas 18, 19, and 20.

There are 9 chum stocks in the Southern Vancouver Island area. The four major stocks are the Chemainus, Cowichan, Koksilah, and Goldstream. Escapements for these stocks have been relatively consistent from the 1953 to 1997, averaging 114,000 chum spawners. During the 1980s and 1990s, chum escapements increased to an average of 166,000 and 160,000, respectively, which are about 75% of the 214,000 target escapement.

**Howe Sound/Sunshine Coast**

There are 56 streams in the Howe Sound/Sunshine Coast area that support chum salmon. However, the Squamish and the Cheakamus are considered the major producers and account for 80% of the total escapement between 1953 and 1997. Total escapement averaged 56,000 chum from 1950s, increased to 131,000 in the 1970s and to 154,000 in the 1980s. Total escapement has declined to 96,000 in the 1990s. The target escapement is 357,500 chum for Howe Sound/Sunshine Coast.

**Burrard Inlet**

There are 13 streams in the Burrard Inlet area that support chum salmon. The Indian River is the major stock and accounts for over 90% of the total escapement to the area. Total escapements have averaged 21,000 from 1953 to 1997 and show a steady increase over time (Figure 4.4). The target escapement is 33,000 chum salmon for Burrard Inlet

**Fraser River**

The Fraser River area includes all of Statistical Area 29, except for Boundary Bay.

Fraser River chum salmon are managed to total abundance rather than as individual stocks. Chum salmon spawning is largely confined to that portion of the Fraser River below Hope. There are 121 streams in the Fraser River that support chum salmon, although 10 stocks support 90% of the total spawning escapement. The largest producers are the Harrison, Chilliwack, Chehalis and Stave rivers. Spawning also takes place in the mainstem of the Fraser River between Chilliwack and Hope but there are no reliable estimates for the contribution of mainstem spawners because of the turbid nature of the Fraser River. Total escapements to the Fraser averaged 99,000 in the 1950s, increased to 250,000 in the 1960s, and to 339,000 in the 1970s. The number of chum returns increased to 518,000 in the 1980s and to 1,003,000 in the 1990s. The Harrison, Chilliwack and Stave River systems account for 56%, 18%, and 9% of the total escapement, respectively. The current target for chum escapement to the Fraser River is 700,000.

**Boundary Bay**

The Boundary Bay area includes the streams that flow in to Boundary Bay, which is part of Statistical Area 29.

In the Boundary Bay area there are 4 passively managed chum stocks. The Campbell River is the largest stock and has contributed more than 80 % of the chum escapement to the area. The average escapement from 1953 to 1997 has been 334 chum. The target escapement for the Boundary Bay area is 5,000 chum salmon.

### 4.5 Summary

Chum escapements to all systems have shown marked fluctuations since 1953. The trend for all fall chum stocks combined is an increase in escapement levels while the trend for summer chum stocks is a decline in escapement levels after 1980.

There is variability in the escapement trends among geographic regions within the ISC. A rather marked decline in escapement trends for fall chum salmon has occurred in Upper Vancouver Island, Kingcome Inlet, Bond and Knight Inlets, and Toba Inlet. Escapements to Seymour and Belize Inlets, Jervis Inlet, Lower Vancouver Island, and Boundary Bay are currently about equal to the long-term average escapements. Escapements to Johnstone Strait, Loughborough and Bute Inlets, Mid Vancouver Island, Jervis Inlet, Lower Vancouver Island, Southern Vancouver Island, Howe Sound and Sunshine Coast, Burrard Inlet, Fraser River, and Boundary Bay show moderate growth. However, most stock groups except for Burrard Inlet and the Fraser River are well below the established target escapement levels.

Escapement levels for summer chums have declined since the early 1980. Summer chums are passively managed and enhancement efforts have not been successful. Changes in the harvest rates for Johnstone Strait sockeye and pink fisheries may be required to rebuild summer chum stocks. Alternately, the non-retention summer chum along with coho during selective fishing for sockeye and pink salmon in Johnstone Strait could increase the number of the summer chum returns.

Fall chum salmon stocks in Upper Vancouver Island, Kingcome Inlet, Bond and Knight Inlets, and Toba Inlet are not responding to the Clockwork management plan, which has reduced harvest rates on chum salmon. Natural rebuilding of these stocks may occur if harvest rates are further reduced. However, the decline of these stocks may result from other factors. The systems in these areas are subject to wide fluctuations in flow. They are characterized by summer freshet conditions resulting from snow and ice melt in the headwaters at high elevations and some of the rivers are also subject to winter floods that result from rain and snowmelt at lower elevations. Many of the streams are turbid. Forestry has been the only development activity in most of these drainages. Extensive clearcutting has exaggerated the natural fluctuations in river flow, changed temperature regimes, and contributed to the instability in these systems (DFO 1988). Chum salmon limit their freshwater life to spawning and incubation and spend their growing period at sea which is far more productive than their natal stream but there is a greater potential for predation in the ocean. Chum salmon typically spawn in the lower sections of rivers where impacts of upstream activities accumulate (Scrivener1991). Chum salmon production is at risk from the impacts of major habitat disturbances such as elevated sediment loads and temperature, unstable river flows and turbidity, which is due in part to logging activities (Hartman et al. 1996). Erosion of stream banks and transport of fine sediment causes a decline in the quality and stability of chum spawning gravel and a decline in egg to fry survival and a reduction in fry size (Scrivener and Brownlee 1989). Increased incubation temperatures accelerate embryonic development and emergence of chum fry (Holtby 1988). Fewer smaller fry and early emigration to the ocean cause fewer adults to return after logging (Scrivener 1991). Chum salmon survival at sea is dependent on ocean conditions that have nothing to do with logging. Chum salmon returns to unlogged streams on the West Coast of Vancouver Island declined with poor ocean conditions and increased when conditions improved, but populations within logged areas did not recover when ocean conditions improved (Scrivener 1991). Although regeneration of forest cover and improved logging practices will improve the hydrology of some systems, chum production is expected to remain low and variable in areas affected by logging. However, when favourable ocean conditions produce increased chum returns then fishing effort should be reduced to allow escapement levels to increase in areas affected by past logging. If spawning habitat has improved then higher escapement levels should increase chum production.

Another factor that contributes to the uncertainty about escapement trends is the effort presently used to obtain the escapement estimates. There is no question that different enumeration methods and levels of effort result in differences in data quality. This is a significant truism given the tendency of each enumerator to apply his own preferred method and level of effort on the streams for which he is responsible. It is doubly important in view of the steady reduction in manpower resources available for enumeration activities over the past several decades. Therefore, streams in most areas can be divided into two very broad categories. In the first category are a few systems, which receive a maximum amount of effort because they are major chum producers or they are utilized as indictors for in-season management decisions. The second and much larger category consists of streams, which are visited infrequently, often to determine little more than presence or absence of spawners; they are typically smaller or less-accessible streams. The reliability of spawning escapement data obviously is much higher in the first category than it is in the second. Areas such as Upper Vancouver Island, Kingcome Inlet, Bond and Knight Inlets, and Toba Inlet fall into the second category. Declining escapement surveys may partially explain the declining trend in chum spawning escapements in these areas. For example no reported escapement enumeration efforts in Toba Inlet area between 1994 and 1996 and limited escapement surveys since 1989. The reported escapements for some chum systems may be artificially high because of the practice of recording escapement numbers for systems that are highly turbid or glacial. Escapement estimates during the 1980s and 1990s have remained relatively high in Loughborough/Bute Inlets compared to the other mainland inlet areas. One factor that has contributed to these high averages is the continued practice of assigning high escapement estimates to large glacial systems like the Homathko, Southgate and Orford rivers. It is impossible to assign a reasonable escapement estimate to a large glacial river from a visual survey. Alternative assessment methods are required to produce meaningful escapement estimates for large glacial systems. In the Fraser River, the escapement estimates for the major chum salmon stocks are derived from mark recapture estimates. Estimates have gone from visual to mark recapture estimates without the benefit of conducting both methods for several years prior to adopting the new method. Mark recapture estimates of salmon are almost always over-estimates of the true population size (Simpson 1984).

To address concerns over the quality of escapement enumeration surveys, changes have been made to ensure standardization of data collection. An escapement enumeration plan is developed each year for chum stocks within the Inner South Coast. Rather than trying to assess all chum salmon streams, a representative group of stocks are selected. Chum salmon spawning streams are assessed for inclusion in the escapement plan using the following criteria: 1) importance of past chum production to overall chum production within each area, 2) importance to in-season management and possibility of terminal commercial fisheries; 3) accessibility and easy of enumeration; 4) hazards; 5) consistency of past enumeration data; 6) presence of ongoing enumeration programs; 7) presence of local community groups interested in participating in stream enumeration. Using the above criteria would result in surveying approximately 140 of the 423 stocks presented in ISC. This not to say that the remaining stocks would not be surveyed but that the effort directed to the remaining stocks would be less and may only include presence or absence information.

The goal of the escapement plan is to provide true and relative abundance estimates with a high degree of resolution for a select number of the chum stocks within the ISC. The abundance estimates are based on the systematic and consistent application of a single standard assessment method for each spawning population. The assessment methods include fences, mark-recapture and area under the curve to provide estimates of abundance. The stocks are to be assessed throughout the season with a minimum of 5 visits. Factors such as weather, water levels and observation conditions (water clarity) affect the number of observations each year. The use of consistent methods and recording what is actually seen without expansion prior to the application of standard methods should improve the reliability of escapement estimates for ISC chum salmon.

# 5.0 Stock Recruitment Analysis of Fraser River Chum Salmon and Comparison to aggregate Clockwork Wild Chum stocks.

## *5.1 Methods*

Stock Assessment analysis usually consists of examining the empirical relationship between the spawning stock size and the subsequent recruitment of the year class (es) produced by that stock. Analysis of this relationship is essential in understanding the dynamics of the stock of interest and is necessary to answer questions of abundance and allocation.

The purpose of this analysis is to update earlier stock/recruit analysis of chum salmon by Beacham and Starr (1982), Beacham (1984) and Joyce and Cass (1992) and to recalculate parameters of productivity of two major groupings of chums; namely wild Fraser River origin chums, and wild clockwork chums. (Catch estimates for individual spawning populations preclude separate evaluations for individual populations.) These parameters will help us to assess the establishment of an appropriate escapement target and optimal harvest strategy. Joyce and Cass (1992) properly point out the need for a probing strategy at high escapements to allow a testing of density dependent effects. They examined brood years 1959 –1986, which did not contain many high escapements. Increased escapements since are incorporated into this analysis.

The Ricker model of the form:

$$R=Se^{a(1-S/b)} + e^{(w)} \tag{1}$$

was fitted over the range of spawner-recruit data (1959-1992 brood years for wild Fraser River data and 1955 to 1993 brood years for the clockwork wild chum data). From equation 1, the returns R in a year t are a function of the spawning escapement S in the previous year(s). Parameter a is the productivity parameter ($e^a$ = return spawners in the absence of density dependence). Parameter b is the density dependent parameter. The parameter w is the residual errors, which are log-normally distributed. This is the preferred form of the Ricker model when applied to salmon populations (Hilborn and Walters 1992, Quinn and Deriso 1999, Brink 1998). For fitting, equation 1 is transformed into

$$Ln(R/S) = a - (a/b)S + w \quad (2)$$

which is a linear model of the form

$$Y = b_0 + b_1X + w$$

where Y = Ln(R/S) is the dependent variable, $b_0$ = a is the intercept, $b_1$ = -a/b is the intercept, and w is the residual. Estimates of parameters a and b are estimated from the subsequent regression. Hilborn (1985a) has shown that the expected value of $e^w$ is not equal to zero when w is normally distributed with a mean of zero but equal to $e^{\sigma 2/2}$ , and therefore, the average stock-recruitment curve will be a Ricker curve with the parameters a' and b' which can be defined as

$$a' = a + \sigma^2/2$$

$$b' = (a'/a)b \quad (3)$$

Hilborn (1985b) has also shown that the optimal stock size for MSY can be approximated by

$$Smsy = b'(0.5 - 0.07a') \quad (4)$$

And the corresponding approximation of optimal harvest rate Umsy is

$$Umsy = 0.5a' - 0.07a'^2 \quad (5)$$

Two other important parameters are the maximum stock size Smax and the maximum recruitment size Rmax. These are calculated as

$$Smax = b'/a'$$

$$Rmax = (b'e^{a'-1})/a' \quad (6)$$

The Harvestable surplus can be then calculated by first calculating

$$MSYSmsy = Smsy * e^{a'[1-(Smsy/b')]} \quad (7)$$

And finally:

$$\text{Harvestable Surplus} = \text{MSYSmsy} - \text{Ssmy} \qquad (8)$$

Chum Clockwork escapements records are up to date but the data from 1997 to the present are to be considered preliminary and are subject to change. Fraser River catches are complete to 1997. The analysis for Fraser stocks (Harrison and surrounding sloughs, Chehalis, Vedder/Chilliwack, and Stave/Nicomen/Norrish) incorporates data from 1959 to 1992 brood years. We cannot use the 1993 brood data because we need complete 1998 catch and escapement of Fraser origin chums to complete the 1993 cohort data. Clockwork chum analysis covers the 1955 to 1992 brood years. These data are shown in Tables 5.1 and 5.2 respectively. The analysis deals with wild origin fish exclusively.

1) Total wild returns (recruitment) were calculated by the following production model.

$$\text{Total Wild Return}_t = \text{Wild Return}_{age3} + \text{Wild Return}_{age4} + \text{Wild Return}_{age35}$$

Where

$$\text{Wild Return by age} = \text{Net Wild Return} * \text{proportion of catch at age}$$

Where age = 3,4,5.

$$\text{Net Wild Return} = \text{Total Wild Catch} + \text{Net Wild Escapement}$$

Where

Net Wild Catch = Total Catch – Enhanced Catch and

Net Wild Escapement = Gross Escapement – Enhanced Escapement

2) Returns/ Spawners were calculated by

Net Wild Returns/ Net Spawners

Where

Net Spawners = All chum spawning in natural or semi-enhanced areas.

This simple model has been used by Joyce and Cass (1992) and was reproduced for comparison purposes.

All model results and raw data were transferred into Stata (release 5) for analysis. Stata is a statistical analysis, modelling, and graphing program. It has been certified accurate for use in medical research.

## *5.3 Results*

**Fraser River Chums**

The recruits vs spawners for the Fraser River chum stocks are plotted in Figure 5.1. An examination of the plot indicates several features commonly seen in stock recruitment relationships: (1) There is a trend for larger spawning stock to produce more recruits, (2) there is evidence of decreasing production at larger stock size, (3) the data is highly scattered, and (4) there is increased variability at higher stock sizes.

The Recruits per Spawner data are plotted in Figure 5.2 and show two typical features; high variability at low stock size and there appears to be a trend for decreased survival or density effects at higher stock sizes.

**Ricker Estimates for Fraser River Chum**

The results of fitting by regression of log R/S vs S with the model described by equations 2 are presented below.

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| Model | .977054203 | 1 | .977054203 | Number of obs = | 34 |
| Residual | 7.82820100 | 32 | .245367672 | F( 1,32) = | 3.99 |
| Total | 8.96769794 | 33 | .271748422 | Prob > F = | 0.0542 |
| | | | | R-squared = | 0.111 |
| | | | | Adj R-squared = | 0.0832 |
| | | | | Root MSE = | .4946 |

| Ln(R/S) | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| b | -6.16e-07 | 3.09e-07 | -1.999 | 0.054 | -1.24e-06 | 1.18e-08 |
| a | .992864 | .1549752 | 6.407 | 0.000 | .6771899 | 1.308538 |

The fit of the model to the data (Figure 5.3) was statistically significant ($p<.05$) but this is barely significant. The density dependent parameter b of the Ricker Model is also barely significant ($p<0.054$) indicating that the slope is marginally different from zero. This allows us to tentatively reject the hypothesis that the returns are simply a linear function of spawning escapement and indicate that some degree of density dependent effects are demonstrated. However, any conclusion must be tempered with the poor correlation as indicated by the Coefficient of Determination ( R-squared) = 0.111. This indicates that only 11.1 % of the variation seen in the Ln(R/S) can be explained by the variation in Spawners.

The regression estimates are:

$B_0$ = a = .992864
$B_1$ = b = -6.16e-07

From equation 3 the Ricker a' value is 1.070352 and the Ricker b' value is 1,737,787

The Stock Parameters as defined in equations 4, 5, and 6 are

| Slope at Origin | Smax | Rmax | Smsy | MsySmsy | Umsy |
|---|---|---|---|---|---|
| 2.916405 | 1,623,566 | 1,741,900 | 738,690 | 1,366,831 | .46 |

The indicated optimal harvest rate is 45.4% and the Harvestalbe surplus is 628,140. Summary of the stock parameters and comparison with other studies are found in Table 5.3.

The predicted linear values $Y = B_0 + B_1 X$ where Y is Ln(R/S) and X is S are also plotted in Figure 5.3.

**Residuals for Fraser River Chums**

The residuals of the model fit are plotted in Figure 5.4. The indicated pattern of the residuals does not indicate any abnormal anomalies. However, two post-fit tests were calculated to test whether there are any problems with the model fit. The results of the Ramsey RESET test using powers of the fitted values of Ln(R/S) for the

Ho: model has no omitted variables

are

F (3, 31) = 8.85
Prob > F = 0.0002

indicating that the null hypothesis should be rejected. This suggests that the simple linear model does not give the best fit and that a more complicated relation between Ln(R/S) and S may be necessary to give a better fit of the observed data.

The Cook-Weisberg test for heteroscedasticity using fitted values of Ln(R/S) for the

Ho: Constant variance

are

chi2 (1) = 0.23
Prob > chi2 = 0.6331

indicated that the null hypothesis is supported. This indicates that variance is constant through the fit supporting the conclusion of no anomalies in the residuals. A summary of the residuals is:

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| resids | 34 | 1.37e-09 | .4870446 | -1.110177 | 1.002613 |

**Fitting the Ricker Curve for Fraser River Chums**

The fit of the Ricker model indicated by equation 1 with the parameters calculated above is plotted in Figure 5.5. Joyce and Cass (1992) speculated that unless there were significant escapements (> 800,000), it would be unlikely that density dependent effects could be tested. The 4 data points since their study that are > 800,000 spawners are important in that the shape of the curve shows that density dependent effects may be operative. Since 1986, there has been a general increase in escapement to the Fraser River. Figure 5.6 shows a clear increasing trend in escapement which has allowed us to calculate a more representative stock-recruitment relationship. We did not fit a curve to this data as the increasing escapement is self-evident. The trend toward increasing escapement continued into 1998 with an estimated at 3.3 million escapement for the Fraser River. This level of escapement is above the established clockwork target.

Along with increased escapement, Figure 5.7 indicates that an increasing trend for wild production up to 1992 has been operative. The results of fitting a linear model of the form $Y = B_0 + B_1 X$ to the production data vs year gives the following results:

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| | | | | Number of obs | = 34 |
| | | | | F( 1, 32) | = 7.61 |
| Model | 1.9026e+12 | 1 | 1.9026e+12 | Prob > F | = 0.0095 |
| Residual | 7.9998e+12 | 32 | 2.4999e+11 | R-squared | = 0.1921 |
| | | | | Adj R-squared | = 0.1669 |
| Total | 9.9024e+12 | 33 | 3.0007e+11 | Root MSE | = 5.0e+05 |

| totalret | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| $B_1$ | 24112.24 | 8740.246 | 2.759 | 0.010 | 6308.945 | 41915.54 |
| $B_0$ | -4.67e+07 | 1.73e+07 | -2.707 | 0.011 | -8.19e+07 | -1.16e+07 |

The fit of the model to the data (Figure 5.7) is significant ($p < 0.01$) and the slope of the line is significant as well ($p<0.01$). However, the Coefficient of Determination (R-squared) = 0.1921 indicating that only 19% of the variation in the production can be explained by the variation in the independent variable. An examination of the residuals did not reveal any anomalies and the post-fit tests did however indicate a problem with omitted variables. The Ramsey RESET test using powers of the fitted values of the production with

Ho: model has no omitted variables

are

$F(3, 35) = 6.46$
Prob > F = 0.0013

leading to a rejection of the null hypothesis. This would indicate that a more complex model would be a better fit to the data. The Cook-Weisberg test for heteroscedasticity using fitted values of the production with

Ho: Constant variance

are

| | | |
|---|---|---|
| chi2 (1) | = | 0.06 |
| Prob > chi2 | = | 0.8040 |

Indicating an acceptance of the null hypothesis that variance in the residuals is constant over the data.

A leverage plot of the data is shown in Figure 5.8a. The data points above the horizontal line have higher than average leverage and the data points to the right of the vertical line have higher than average residuals. The pattern shown indicates that there are slightly more points with higher than average leverage than with larger than average residuals. This diagnostic indicates that there may be some cyclic behaviour in the residuals. As the Ramsey reset test indicated that the model had omitted variables; to discern the functional form of the model, a component plus residual plot was done and is presented in Figure 5.8b. The graph indicates that although an increasing linear trend is present, the proscribed functional form of the model may bears out the cyclic nature of the residuals. This may indicate a cyclic behaviour component or at the very least, non-linearity in Fraser River chum production. 80 and 95% bootstrap confidence limits for the Ricker parameters are presented in Appendix 2.

**Clockwork Chums**

The recruits vs spawners for the Clockwork (all wild) chum stocks are plotted in Figure 5.9. An examination of the plot indicates that like the Fraser River data, there are several features commonly seen in stock recruitment relationships: (1) There is a trend for larger spawning stock to produce more recruits, (2) there is evidence of decreasing production at larger stock size, (3) the data is highly scattered, and (4) there is increased variability at higher stock sizes.

The Recruits per Spawner data are plotted in Figure 5.10 and again show two typical features; high variability at low stock size and there appears to be a trend for decreased survival or density effects at higher stock sizes.

**Ricker Estimates for Clockwork Chum**

The results of fitting by regression of log R/S vs S with the model described by equation 2 are presented below.

```
------------------------------------------------------------------------------------------------------
  Source |      SS          df          MS                   Number of obs  =    39
---------+--------------------------------------------        F(  1,32)      =  2.92
   Model |  1.03310099     1        1. 03310099                Prob > F      =  0.0957
```

| | | | | | |
|---|---|---|---|---|---|
| Residual | 13.0804057 | 37 | . 353524479 | R-squared | = 0.0732 |
| | | | | Adj R-squared | = 0.0482 |
| Total | 14.1135067 | 38 | .371408072 | Root MSE | = .59458 |

| Ln(R/S) | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| b | -3.82e-07 | 2.23e-07 | -1.709 | 0.096 | -8.34e-07 | 7.07e-08 |
| a | .8876809 | .2540885 | 3.494 | 0.001 | .3728488 | 1.402513 |

The fit of the model to the data (Figure 5.11) was not statistically significant (p>.09) but this is barely non -significant. The density dependent parameter b of the Ricker Model is also barely non-significant (p>0.096) indicating that the slope is not different from zero. This does not allows us to tentatively reject the hypothesis that the returns are simply a linear function of spawning escapement and indicate that a small degree of density dependent effects are demonstrated. However, any conclusion must also be tempered with the poor correlation as indicated by the Coefficient of Determination ( R-squared) = 0.0732. This indicates that only 7.3% of the variation seen in the Ln(R/S) can be explained by the variation in Spawners.

The regression estimates are:

$B_0$ = a = .8876809
$B_1$ = b = -3.82e-07

From equation 3 the Ricker a' value is 1.014725 and the Ricker b' value is 2,659,544.

The Stock Parameters as defined in equations 4, 5, and 6 are

| Slope at Origin | Smax | Rmax | Smsy | MsySmsy | Umsy |
|---|---|---|---|---|---|
| 2.758605 | 2,620,950 | 2,659,830 | 1,140,863 | 2,036,482 | .44 |

The indicated optimal harvest rate is 43.5% and the Harvestable surplus is 895,619.

The predicted linear values $Y = B_0 + B_1 X$ where Y is Ln(R/S) and X is S is also plotted in Figure 5.11.

**Residuals for Clockwork Chums**

The residuals of the model fit are plotted in Figure 5.12. The indicated pattern of the residuals does not indicate any abnormal anomalies. However, two post-fit tests were calculated to test whether there are any problems with the model fit. The results of the Ramsey RESET test using powers of the fitted values of Ln(R/S) for the

Ho: model has no omitted variables

are

| | | |
|---|---|---|
| F (3, 34) | = | 0.98 |
| Prob > F | = | 0.4144 |

indicating that the null hypothesis should not be rejected. This suggests that the simple linear model gives the best fit and that a more complicated relation between Ln(R/S) and S may not be necessary.

The Cook-Weisberg test for heteroscedasticity using fitted values of Ln(R/S) for the

Ho: Constant variance

Are

| | | |
|---|---|---|
| chi2 (1) | = | 0.19 |
| Prob > chi2 | = | 0.6022 |

Indicated that the null hypothesis is supported. This indicates that variance is constant through the fit supporting the conclusion of no anomalies in the residuals. A summary of the residuals is:

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| resids | 39 | 3.58e-10 | .5867037 | -1.667917 | .9546214 |

**Fitting the Ricker Curve for Clockwork Chums**

The fit of the Ricker model indicated by equation 1 with the parameters calculated above is plotted in Figure 5.13. The data and fitted line indicate that density dependent effects are operative.

As with the Fraser River chum, the escapement of clockwork chums has increased since 1980. This increasing trend in escapement can be clearly seen in Figure 5.14.

Along with increased escapement, Figure 5.15 indicates that an increasing trend for wild production up to 1993 has been operative. The results of fitting a linear model of the form Y = $B_0 + B_1$ X to the production data vs year gives the following results:

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| Model | 4.6494e+12 | 1 | 4.6494e+12 | Number of obs | = 39 |
| Residual | 3.9245e+13 | 37 | 1.0607e+12 | F( 1, 37) | = 4.38 |
| Total | 4.3894e+13 | 38 | 1.1551e+12 | Prob > F | = 0.0432 |
| | | | | R-squared | = 0.1059 |
| | | | | Adj R-squared | = 0.0818 |
| | | | | Root MSE | = 1.0e+06 |

-----------------------------------------------------------------------------------------------

| totalret | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| $B_0$ | 30678.42 | 14653 | 2.094 | 0.043 | 988.6126 | 60368.22 |
| $B_1$ | -5.87e+07 | 2.89e+07 | -2.028 | 0.050 | -1.17e+08 | -60264.56 |

The fit of the model to the data (Figure 5.15) is significant ($p < 0.04$) and the slope of the line is significant as well ($p<0.043$). However, the Coefficient of Determination (R-squared) = 0.1059 indicating that only 10% of the variation in the production can be explained by the variation in the independent variable. An examination of the residuals did not reveal any anomalies and the post fit tests did not indicate a problem with omitted variables. The Ramsey RESET test using powers of the fitted values of the production with

Ho: model has no omitted variables

are

$$F(3, 34) = 0.32$$
$$\text{Prob} > F = 0.8117$$

leading to an acceptance of the null hypothesis. This would indicate that a more complex model would not be a better fit to the data. The Cook-Weisberg test for heteroscedasticity using fitted values of the production with

Ho: Constant variance

are

$$\text{hi2}(1) = 0.17$$
$$\text{Prob} > \text{chi2} = 0.6762$$

indicating an acceptance of the null hypothesis that variance in the residuals is constant over the data.

A leverage plot of the data is shown in Figure 5.16a and component plus residual plot was done and is presented in Figure 5.16b. Unlike the Fraser River data, the clockwork data indicate that the linear model is the appropriate functional form. The 80 and 95% bootstrap confidence limits for the Ricker parameters are presented in Appendix 2.

### *5.4 Summary*

Returns of Fraser River and clockwork chum salmon have fluctuated widely, however, recent increased escapement levels and increased production have allowed us to detect density dependent effects that were not apparent in earlier studies. The trend in increased escapement and production would indicate that the Clockwork strategy has progressed as planned, with the target level escapement of 2.5 million exceeded in 1998 (preliminary estimate). Comparisons of the major stock parameters from earlier studies are shown in Table 5.3.

The current data results for Fraser River chum closely follow results from Joyce and Cass (1992). The present study estimates Smsy of 739,00 (479,000 – 2,482,000 80%CL) versus 485,000 estimated by Joyce and Cass (1992). Optimal harvest rates for the two studies are in agreement at 45-46%.

There is though, a large discrepancy between the results found here for wild Clockwork chum and those found by Beacham (1984). The additional years of data in the present analysis indicate a vastly different relationship and the possibility of density dependent effects that were not observed in the earlier data set. Consequently, the estimate for Smsy is estimated to be only 1,140,000 (812,000 – 4,212,000 80%CL) in this analysis versus 2,887,000 estimated by Beacham (1984). It should be noted though, that our relationship is heavily influenced by a single data point 1985. If this point is removed, the estimate of Smsy increases from 1,1,40,000 to 2,430,000. Given the large uncertainty in the b parameter and the marginal significance of the stock-recruit relationship we urge caution in the application of the stock-recruit model to estimate Smsy. We also note the large disparity between the stock-recruit estimate of Smsy of 1,140,000 for all wild Clockwork stocks and estimate of spawning habitat discussed in section 4.0.

Estimates of exploitation reveal a slight decrease from the average of 44% in the 1950s to 38% in the 1980s to 27% in the 1990js (Figure 5.17). The average exploitation rate for the period covering Clockwork management (1983-1993) was 37%. This is slightly less than the Umsy estimate of 45% (39% - 53%; Umsy 80% CL).

# 6.0 Mission Downstream Data

## *6.1 Methods*

Joyce and Cass (1992) used the relationship between standardized fry CPUE measured at Mission and subsequent adult returns for the 1964 to 1986 brood years to assess potential density dependent marine survival effects. The fry index measured at Mission does not include stocks below Mission however, it is assumed to be representative of fry abundance (Joyce and Cass 1992). Joyce and Cass (1992) found no evidence of density dependent marine effects on fry survival.

## *6.2 Results*

The results of the linear fit of standardized fry CPUE vs total adult returns for that brood year are as follows:

```
Source    |     SS          df      MS              Number of obs =     28
-----------+-------------------------------------        F(  1,    26)  =   19.38
```

| | | | | | |
|---|---|---|---|---|---|
| Model | 3.1469e+12 | 1 | 3.1469e+12 | Prob > F | = 0.0002 |
| Residual | 4.2217e+12 | 26 | 1.6237e+11 | R-squared | = 0.4271 |
| | | | | Adj R-squared | = 0.4050 |
| Total | 7.3686e+12 | 27 | 2.7291e+11 | Root MSE | = 4.0e+05 |

| totalret | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| totalcpu | 495.8424 | 112.6319 | 4.402 | 0.000 | 264.3243 | 727.3605 |
| _cons | 222872 | 195011 | 1.143 | 0.264 | -177978.9 | 623722.9 |

Fry CPUE is linearly correlated with subsequent adult brood year returns ($p<0.0002$) for the 1964 to 1992 brood years. Within the range of these observations there is no evidence for density dependent marine effects on survival. These findings are consistent with the conclusions reached by Joyce and Cass. The graph of standardized fry CPUE vs total adult returns with the predicted values are plotted in Figure 6.

To assess whether the linear relationship between standardized fry CPUE vs total adult returns can be used for predictive purposes, a heuristic retrospective analysis was done to assess the predictive relationship between measured fry CPUE and subsequent returns. For the brood years 1986 to 1992, regression data was calculated for data up to and including that brood year. The subsequent fry CPUE was then used to estimate the expected total return of adults from that brood year. The prediction was then compared to the total return for that brood year and a percent difference was calculated. The algorithm is heuristic albeit in a simplistic sense, as each year incorporates new information into the regression estimates.

The results show that for the 1986 to 1992 brood years, there is a wide range of percent difference (error) between years (Table 6.1).

### *6.3 Summary*

For most of the years, the prediction overestimated the Total Returns. From these results, it would appear that the use of the Standard Fry CPUE is not a particularly useful tool for prediction of Total Returns in this present form. This is not entirely unexpected, as the fitted model is a linear with low correlation between the variables (mean Coefficient of Determination – R squared for 1986 to 1992 was 0.478).

## 7.0 Retrospective Analysis of In-season Run Size Techniques

One of the most important components of an in-season salmon fishery management system is the estimate of returning run size. This figure determines the total number of salmon available for harvest. Managers rely upon these figures to schedule fishery openings, to ensure that catch is allocated among various user groups and to meet specified harvest rate targets or escapement goals. Errors in the process of estimating the run size can trigger or postpone commercial openings, which may lead to under or over-escapement to spawning grounds and/or fisheries closer to the natal rivers. Pre-Season forecasts and in-season run size estimates are also used by fishermen to make decisions regarding how they will allocate their effort among various fishing opportunities.

Many models have been developed for estimating returning run abundance. Run size estimates can be obtained from pre-season forecasts, commercial fisheries (catch and catch per unit effort (CPUE)), test fisheries and in combination with spawning escapement monitoring. The process of estimating run strength occurs over the length of migration, producing an array of run size estimates. The manager must then combine these estimates to produce a "best" estimate. Managers generally consider in-season estimates more reliable than pre-season estimates (Walters and Buckingham, 1975). A number of authors (Fried and Hilborn, 1988; Fried and Yuen, 1987; Henderson et al., 1987) have proposed and evaluated various techniques to both estimate run size and how to combine several independent indicators of run strength.

The purpose of this section is to:

1. Describe the models currently used for assessing the returning strength of chum salmon to the inside waters of southern British Columbia (Figure1.1)

2. Determine whether one model performs with more consistent accuracy than any of the others.

3. Finally to determine whether run size estimation can be improved by pooling results from independent models.

## *7.1 Methods*

**Model**

Six models, one pre-season and five in-season, were constructed to forecast total stock size. The pre-season wild stock prediction for each year *i* from 1988 to 1997 was calculated by determining the average proportion of 3-, 4- and 5-year olds in the returning stock over the period 1980 to 1994. These proportions were based upon chum salmon scales collected from test and commercial fisheries in Johnstone Strait and the Fraser River. Next, the expected total return from years *i*-3, *i*-4 and *i*-5 was calculated by taking the product of the escapement and the return rate per spawner. The average proportion of age 3, 4 and 5's in the most recent 15 brood years (1979-1993) has been 17%, 70% and 13%, respectively. The average return per spawner over the same 15 brood years was 1.7:1.0. Finally, returns from each brood year were summed to produce the predicted wild run size for year *i.* For the enhanced component contribution to the total returning run size, run size was estimated by applying survival rates for each type of enhancement facility and the average return by age group, to the number of fry released by the facilities. The total return was then the sum of the wild and enhanced components.

The five in-season models all had the same structure of the form:

$$LN(\hat{Y})_{i,j} = LNa + b\ LN(X)_{i,j}$$

where $\hat{Y}_{i,j}$ equals the predicted total run size estimated from data source *i* and time *j*, $a$ = the y-axis intercept, $b$ = slope of the regression line, and $X_{i,j}$ = data from data source *i* for time period *j*. The five data sources for the in-season model are: (1) test fishing CPUE by week or cumulative CPUE; (2) total commercial catch (seine and gill net) in a Johnstone Strait fishery; (3) commercial seine gear catch in a Johnstone Strait fishery; (4) commercial seine gear CPUE; (5) pooled estimate combining a test fishery estimate with one of the other model estimates. Pooling was based upon the residual mean square error (RMS) (Hilborn and Walters, 1992).

$$\overline{R}_j = \sum_{i=1}^{2}[R_{i,j} \times (1/RMS_{i,j})] / \sum_{i=1}^{2}(1/RMS_{i,j})$$

where $\overline{R}_j$ = weighted mean run size for time *j*; $R_{i,j}$ = estimated run size for time *j* and method *i*; and $RMS_{i,j}$1 = residual mean square error from the linear regressions for time *j* and method *i* derived in equation (1).

A hindcasting procedure was used to examine the predicative capabilities of the various models. Only data prior to the year of interest was used to calculate the predictive equations. Simulations were conducted for the years 1988 to 1997. Run size estimates are classified into pre- and early-season, mid-season and final. The pre- and early season includes the pre-season forecast, test fishing results in the fourth week of September (9/4) and a commercial fishery held the same week. Mid-season includes cumulative test fishing CPUE from the fourth week of September to the second week of October (10/2) and any commercial fisheries held during the second week of October. The final estimate is derived from cumulative test fishing CPUE from the fourth week of September up to and including the third week of October (10/3) and any commercial fisheries held after the second week of October. Predictive regressions were only used if F-tests for the model were significant at the 95% level.

Three methods of comparing run size estimates were used: (1) annual percent error, (2) mean percent error (MPE); and (3) mean absolute percent error (MAPE). Annual percent error was calculated as:

$$[-(A_k - R_{i,j,k}) / A_k] \times 100$$

where $A_k$ = actual run size in year *k* and $R_{i,j,k}$ = predicted run size for time *i* with model *j* and in year *k*. MPE provides for a measure of bias in any of the methods used; examining for persistent over- or under-estimates of run size. To assist in examination of the range and distribution of under-forecasting (negative MPE) and over-forecasting (positive MPE) bar charts were constructed. MAPE yields a measure of overall model performance with over- and under-estimates in run size treated equally.

## *7.2 Results*

The size of the Clockwork chum salmon run varied from a low of 1,383,000 in 1997 to a high of 4,858,000 in 1994 over the ten years examined. Escapement range had less variation, ranging from a low of 980,000 in 1989 to over 2,812,000 wild spawners in 1994. The average total return during the ten years examined was 3,100,000. Clockwork chum salmon start to migrate through Johnstone Strait from about mid-September and the run is generally completed its migration through Johnstone Strait by about the end of October. The run timing as measured by cumulative test fishing CPUE in Johnstone Strait varies considerably among years, with the 1989 run arriving the earliest and the 1994 run the latest (Figure 7.1). The actual dates when 50% of the run had passed the Johnstone Strait test fishery ranged from October 2 in 1989 to October 19 in 1995. The mean 50% date pass the Johnstone Strait test fishery is October 11 for the years 1988 through 1997.

**Pre- and Early Season**

The accuracy of the various models tested (Pre-season, Test Fishing CPUE, Total Catch, Seine Catch and Seine CPUE) varied greatly both among and within years (Table 7.1 and 7.2). The pre-season forecast had the largest deviation from the true run size during the Pre- and Early Season time frame. In years 1995-1997 the pre-season forecast over estimated the true run size by 173%, 243% and 259%, respectively. The pre-season forecast produced the largest errors from the true run size; accounting for six out of the ten years examined. The test fishing model had three years that produced the largest magnitude in error from the true value and finally the seine CPUE model had one year in which its estimate produced the largest magnitude error from the true value.

With respect to overall model performance there was no single model that outperformed all the others. The MAPE's for all models ranged from a low of 9.4% for the Total Catch model to a high of 88.8% for the pre-season model. Most troubling was an overall tendency for all models to over-estimate the true run at this stage of the returning migration. Finally, the weighted model estimates had MPE and MAPE values that were lower or intermediate than those of its components.

**Mid-season**

Overall, the individual models improved in their forecasting ability from the earlier time frame as evidenced by a reduction in their MAPE value's. This improvement in forecasting ability was evidenced by large decreases in the RMS over the course of the season (Figure 7.2). The best model for estimating run size was the seine CPUE or seine catch. Both of these models outperformed either the cumulative test fishing or total commercial catch models. However, it should be observed during this time period there were only three years which had commercial fisheries to allow us to construct run size estimates.

There was still an overall over-estimate of the true run size, though to a much lesser degree than early in the run migration. As in the Pre- and Early Season time the weighted model estimates for this time frame had MPE and MAPE values that were lower or intermediate than those of its components.

**End of Season**

Once again, no single model performed consistently better than any of the others. For this time frame the weighted estimates performed slightly better than their individual components. As with the mid-season time frame there was a reduction in MAPE values from the pre- and early-season time frames. There was once again a tendency for the MPE values to be positive indicating a tendency to over-estimate the returning run size by all models. The cumulative test fishing model over-estimated 8 of years that we have estimates. The Total Catch and seine catch models had five out of six years and the seine CPUE model's had four out of six years that over-estimated the true run size.

## *7.3 Summary*

The above analysis describes the current technique used to estimate the run strength of chum salmon returning to the 'Study Area'. The results show that no one single model examined in this paper outperformed any of the others. It did show though, that pooling of the individual estimates generally improved the overall accuracy and reduced the bias (as measured by MPE) of the run size estimates produced. This result is in agreement with results of Fried and Yuen (1987) who examined a similar pooling methodology for forecasting the returning sockeye salmon run strength to Bristol Bay, Alaska. Fried and Hilborn (1988) also examined Bayesian probability theory to produce in-season estimates for sockeye salmon returning to Bristol Bay, Alaska. They also found that while the Bayesian method was not always more accurate than the most accurate individual method, it was always more accurate than the least accurate individual method.

A number of findings in the present study have some results of interest to management of the 'Study Area' chum salmon fishery. Firstly, there is the generally poor performance of the pre-season forecast. Its utility for helping to manage Clockwork stocks is extremely questionable. This was extremely evident during 1995-97 when the pre-season forecast was greater than 4.2 million and the actual return was less than 1.5 million. Second, there was the noted result of over-estimating the actual magnitude of the returning Clockwork chum salmon run size. This tendency to over-estimate persists over the three time strata examined, but was at a minimum during the peak of the run. This tendency to over-estimate has the potential effect of scheduling additional harvest when it doesn't exist. This is particularly noticeable in 1989 when the run timing 50% date was October 2 (Fig. 7.1). The mean 50% date is about October 11 (95% C.L. of 5 days). While this explains the initial over-estimation early in the season it does not explain the continuing over-estimation of run size throughout the fishing season.

The third important finding from this analysis is that while the MAPE averaged 12-20% using the commercial fishery models at the peak of the season there was still 4 years out 10 that over-estimated the run size by 60-70% with the test fishing models. While the current models have a tendency to over-estimate the run size and potentially create a 'paper' surplus, the stepped harvest rate management regime in place for the Clockwork chum salmon ameliorates the over-estimation problem. When the levels for the various harvest rates were being developed it was recognized that in-season estimates not very reliable and consequently conservative harvest rates were set. For example, in 1995 the run size was consistently over-estimated with the mid-season estimate of 2.5 million versus an actual return of only 1.5 million or an over-estimate of 62%. However, since the first harvest step of 20% doesn't take effect until run sizes of greater than 3.0 million are estimated, no fisheries were scheduled.

All the models examined in the present study require estimates of catch and escapement. Naturally, the reliability of these models will depend upon the quality of these data. While the catch statistics are considered reasonably easy and consistently collected, the same cannot be said for the escapement data. As pointed out earlier, there are a large number of streams contributing to the 'Study Area' chum salmon and a wide variety of escapement methodologies applied. These escapement methodologies range from foot or aerial surveys, to mark recapture and also fences on some systems. The increased uncertainty in both catch and escapement will affect the results in this study.

# 8.0 Review of Fishery Management 1983-1997

## *8.1 Management Objectives*

Management of ISA chum stocks is governed by:

- The optimum wild escapement: hypothesized to by about 2.5 million spawners based upon habitat capacity (Palmer 1972, Fraser et al. 1974) and stock recruitment analysis (Beacham 1984 and Luedke, 1990). This includes an escapement of 700,000 for Fraser River.
- Reach the optimum wild escapement within 12 to 15 years.
- Allow limited fishing at low stock size.
- Stabilize the annual catch. There should be few years with no fishing.
- Determine how accurate the estimated optima escapement of 2.5 spawners is by allowing for escapements larger than the 2.5 million.

Prior to 1983 the management of Johnstone Strait and Fraser River chum fisheries were set based upon a fixed escapement strategy. Chum salmon recruitment is quite variable and with a fixed escapement approach applied to a variable recruitment results in large harvest variability.
A stepped harvest plan allows for more flexibility in the spawning targets, thereby allowing for some harvest in most years. The stepped harvest plan schedule for Clockwork applied to

Johnstone Strait fisheries after September 1 (Figure 8.1). The Johnstone Strait harvest steps currently in place are:

| Wild Stock[1] | Total Stock[2] | Harvest Rate |
|---|---|---|
| 0.0 – 2.0 million | 0.0 – 3.0 million | 10%[3] |
| 2.0 – 2.9 | 3.0 – 3.9 | 20% |
| 2.9 – 4.2 | 3.9 – 5.2 | 30% |
| over 4.2 | over 5.2 | 40% |

*[1] Wild stock includes populations with at least 25% of the return from wild spawning.*

*[2] Total stock equals wild plus enhanced plus U.S. components. During 1987 to 1998 the preseason expected enhanced component has been set at 900,000, but may vary dependent upon HEB expectations. U.S. component was set at 100,000.*

*[3] The 10% harvest rate includes non-commercial catch, commercial fisheries and test fisheries. At a stock size below 3.0 million, commercial fisheries in Johnstone Strait would not be scheduled after the September assessment fishery.*

As presented in the previous section the magnitude of the returning run is assessed by three methods. First, is the pre-season forecast derived from returns/spawner, fry survival, etc. Second, correlation between commercial fishery catch and total run size. Lastly, correlation between the Johnstone Strait test fishery catch and total run size.

This section will attempt to address three basic questions in order to assess the effectiveness of the Clockwork management plan:

1. Given the in-season run size assessment was the desired fishery objective achieved?
2. How accurate was the in-season assessment in relation to desired and actual harvest rates?
3. Are the escapement levels both from Johnstone Strait and on the spawning grounds assumed in-season actually being met?

The next two paragraphs answer the above three questions from the viewpoint of existing goals and the third paragraph re-examines the appropriateness of the goals.

Figure 8.2a shows the estimated desired harvest rate based upon the in-season estimate of stock size and the actual in–season harvest rate. There are two instances where the in-season estimate of harvest rate is much larger than the desired; 1989 and 1990. In both years the run size was over-estimated in-season resulting in further fishing opportunities. In 1995, run size assessment late in the season resulted in estimating a run size of 3.o million up from previous estimates. This re-evaluation moved the harvest rate from 10% to 20% and provided a fishing opportunity.

From the in-season point of view it would appear that in-season assessment failed. Overall though, comparison of the actual and desired harvest rates over the 15 years suggests with the information available in-season, the fisheries are being managed fairly well from the in-season point of view.

The next comparison is of post-season desired and actual harvest rates (Figure 8.2b) reveals we were somewhat less successful in achieving our harvest rate goals. In four years (1986, 1988, 1989 and 1990) the actual greatly exceeds the desired harvest rate. From 1992 onwards, the post-season actual and desired harvest rates track each other quite well. The close agreement in actual versus desired harvest rates from 1992 onwards occurred over both large and small run sizes. The improved results from 1992 onwards, may partly be due to modification of the in-season run size estimation procedure starting in 1993. Firstly, the pre-season forecast was removed from the in-season calculation of run size and secondly the in-season run sizes estimates from independent models were combined using the inverse of their variances as weights (PSARC 95-08).

Figure 8.2c is a comparison between post-season escapement from Johnstone Strait as a result of the actual and desired harvest rates. This comparison would indicate that the management and stock assessment system in place is achieving the prescribed escapements from Johnstone Strait quite well. Finally there is a comparison between wild escapement and the goal (Fig 8.2d). Total escapement was increasing during the late 1970s and early 1980s; with a peak in 1985 (Table 5.2). They then declined until a low was reached in 1989. Escapements then increased for several years, reached a second peak in 1994 and then declined in 1996 and 1997 due to very low returns. Preliminary indications for 1998 escapement are indicative of a wild escapement much greater than 2.0 million. Casual observation might lead one to conclude that the since the escapement goal was not met in 7 out of 15 years that the Clockwork plan is not succeeding. However, natural variability in returning stock strength prevents reaching the wild escapement goal when the actual total return is less than 2.0 million. The measure of success is then whether the stock assessment capabilities where able to discern the true stock size and allow managers to implement the correct fishery action. When figure 8.2c is examined from that perspective it would then appear that there where few years where escapements to the wild spawning grounds could have been significantly increased by reducing harvest.

## *8.2 Trends in Stock Production*

Since the initiation of the Clockwork management program in 1983 and increased enhanced production from 1985 onwards there has been an increase in returns (Figure 8.3). The total wild average production from 1968-82 was 2.1 million and 1983-97 was 2.4 million. All of the increase in production was due to the Fraser River component of Clockwork stock. Fraser River chum average return increased 800,000 (1968-1982) to 1.3 million (1983-1996) or a 63% increase. In contrast we observed a slight decrease for the Canadian non-Fraser wild of 15%. The average return for this group was 1.3 million during 1968-82 and 1.1 million for the years 1983-96.

It was hypothesized that implementation of the Clockwork management regime in 1983 may result in temporary or permanent changes in salmon production and abundance in the related riverine or oceanic systems. To determine the impact of future fishery management decision, it is vital to quantify the past interventions on the system and then rational decisions can be made to ensure the management goals can be achieved. However available historical data are time series structured, this implies that the time series analysis, instead of traditional statistical methods, should be implemented. The general model to describe the time series with interventions is so-called the transfer function noise (TFN) model. In this section, the time series intervention analysis is introduced to demonstrate the impact for fishery policy on chum salmon production in British Columbia.

**Model**

We employ following TFN model (Box and Tiao 1975):

$$\mathbf{R_t = f ( x_t, I_t ,}\ \mathrm{b}\ \mathbf{) + N_t} \qquad \mathbf{(1)}$$

where $\mathbf{R_t}$ is the chum salmon production time series at year t. $\mathbf{f(x_t, I_t ,}\ \mathrm{b}\ \mathbf{)}$ is the deterministic component of response $\mathbf{R_t}$, which includes a set of exogenous covariate series $\mathbf{x_t}$ and a set of intervention series $\mathbf{I_t}$ and the unknown parameter b. $\mathbf{N_t}$ represents the stochastic noise series, which may be autocorrelated. To simplify our discussion, we make choice of $f\ \mathbf{( x_t, I_t ,}\ \mathrm{b}\ \mathbf{)} = \mathrm{m} +$ b $\mathbf{I_t}$, where $\mathbf{I_t}$ is the covariate to describe the fishery policy intervention under year 1983, which is defined as $\mathbf{I_t} = 0$ if $t < 1983$ or 1 if $t \geq 1983$. Parameter m is to describe the mean of the chum salmon production and b is the parameter to measure the mean shift before and after intervention. The stochastic noise series $\mathbf{N_t}$ in (eq 1) can be expressed as $\mathbf{N_t = R_t - f ( x_t, I_t ,}\ \mathrm{b}\ \mathbf{)}$. It may be modeled as typical mixtures of autoregressive integrated moving-average (ARIMA) models. This type of model associates the current observed chum salmon production value to the observed in the past, which is the fact in the fisheries where the fish abundance or production now is closely related to the abundance or production in the same stock in the past. The mathematical form for ARIMA model is defined as follows:

$$f\mathbf{(B)}\tilde{N}^{\mathbf{d}}\ \mathbf{N_t} = q\mathbf{(B)}\ e_t \qquad \mathbf{(2)}$$

where B is the backshift operator, $\phi(B) = 1 - \phi_1 B - \ldots - \phi p B^p$, $\theta(B) = 1 - \theta_1 B - \ldots - \theta q\ B^q$, $\nabla^d = (1-B)^d$. This model is denoted by ARIMA ( p, d, q ). The special case of ARIMA (0,0,0) implies that time series observations are independent.

Box and Jenkins (1976) developed a paradigm for fitting ARIMA models, which is to iterate the three basic steps: a) model identification, b) estimation of model parameters and c) model diagnostics. Model identification step is to determine the ARIMA model orders (p,d,q). Several criterions can be used in this step. In the initial model identification stage, the autocorrelation function (ACF) and the partial autocorrelation function (PACF) as well as the associated 95% confidence band can be used. An overall procedure is to use a penalized log-likelihood measure. One of such measure is the well-known Akaike's Information Criterion (AIC)(Akaike 1974) defined as: AIC=-2(maximized log likelihood function)+2k, where k is the number of parameters being estimated. The smaller the AIC, the better the model fitted. If the AIC is used for the model identification, the maximum likelihood estimation should be used to estimate the model parameters and the associated standard error. The residuals can be used for model diagnostics, which should behave approximately as white noise.

**Analysis**

The chum salmon production time series data is illustrated in Figure 8.3. In the figure, the horizontal dashed line is the grand mean of the time series and the solid line is the mean before and after the implementation of the fishery policy for Fraser River, non-Fraser rivers and the total. It can be seen that the mean production appears to have been shifted by the fishery policy intervention. More specifically, the mean production in Fraser River is largely increased. However the mean production for non-Fraser River has declined slightly. The combination of the two results in an overall slight increase for the total chum production. The question we try to address is whether this mean change is statistically significant. The time series intervention model presented above provides a viable tool to address this question.

We started with $N_t$ in equation 1 to be white noise, i.e. ARIMA (0,0,0), the estimated model parameters can be seen from Table 8.1. We analyzed the auto-correlation function, partial auto-correlation function and the associated 95% confidence intervals of the residuals for ARIMA (0,0,0). There were no significant indications for time series correlation. As a further confirmation, we fitted the data to intervention models of ARIMA (1,0,0) and ARIMA (0,0,1). The summary of model parameter estimates, variance estimates and the AIC values are presented in Table 8.1. All the parameters for auto-regressive and moving-average were not statistically significantly different from zero (t-value <1). The overall evaluation based on the AIC criterion persuaded us to use the simple ARIMA (0,0,0) model. Based on this model, it can be concluded that the intervention of fishery policy is statistically significant (t-value=3.579) for Fraser River chum salmon production, but not significant for non-Fraser River (t-value=-0.533) and the total production (t-value=1.266) chum salmon.

The high productions in the year 1972 and 1973 make the mean production before the intervention high. To study the impact of these two high production years, we analyzed the data from 1974 to 1996 using the same approach. The overall performance tended to still allow us to use the ARIMA(0,0,0) model. The intervention parameter $\beta$ is now more significant than the analysis to use the data from 1968 to 1996. The summary is presented in Table 8.2 and the plot can be seen from Figure 8.4. Although the intervention parameter $\beta$ is still not statistically significant for Non-Fraser and Total production, however the $\beta$ is changed from negative to positive for Non-Fraser production, which indicates a slight mean production increasing instead of decreasing. Also the $\beta$ parameter for the Total production is increased 87% from 0.300(million) to 0.562(million).

## 9.0 General Conclusions and Recommendations

The results of our review would indicate that overall the Clockwork management has been successful in achieving a number of its objectives. Namely the strategy has allowed for limited commercial fishing in most years, increased wild escapement levels overall and helped to increase our understanding of the optimal target escapement levels. That said, there remains significant concern over the level of escapement enumeration and accuracy of the escapement estimates upon which the Clockwork strategy and this stock status review depends. We believe significant improvements are required for chum escapement enumeration. We have noted earlier in this document that this is occurring in some areas and we strongly support the continuance and development of those programs. In 1998, preliminary escapement estimates to the Fraser River are in the order of 3.4 million and significantly greater than the current target of 700,000. The in-season Albion test fishery escapement estimate of 1.4 million was less than 50% of the post-season. This apparent disparity between the two should cause concern for managers of Fraser River chum. We recommend that a PSARC review of the programs used to estimate Fraser River escapement is required.

While there is a general increase in wild escapement levels, it would appear that not all areas have responded equally. Specifically, escapement records to Upper Vancouver Island, Kingcome Inlet, Bond and Knight Inlets and Toba Inlet show apparent declines to escapement levels. We caution in arriving at the conclusion that over harvest is the cause of the decline. Other factors such as lack of escapement enumeration effort to some of these areas and possible habitat issues may be the agent and this needs to be explored in greater detail.

The current wild escapement goal is set at 2.0 million. The Clockwork management plan called for reaching the interim goal of 2.5 million in 12-15 years or 1995-1998. Results from the present stock-recruit analysis suggests the Smsy level is 740,000 (479,000 – 2,482,000; 80% CL) for Fraser River chum. Recent record escapement will allow us to test this conclusion in the near future. At this time we recommend no change to the current minimum escapement target for Fraser River of 700,000. With respect to the overall goal, our analysis was significantly divergent from Beacham's (1984). This result is not surprising given the increase in the number of years available for inclusion in our analysis. Anecdotal information would suggest that the 1985 brood year should be removed from the analysis due to atypical freshwater mortality and thus the high escapement in 1985 produced extremely low recruitment. When the 1985 brood was removed from the analysis the estimate of optimal escapement was 2.4 million. As we have 4 more years (1993-1996 and 1998) of estimated escapement above or near 2.0 million that cannot as yet be included in the analysis we recommend leaving the wild escapement goal at 2.0 million until such time these additional years can be included.

Finally, while in-season estimates of run size have provided reasonably accurate estimate in comparison to the final run size estimates. There has been a number of years where the in-season and final estimate were significantly divergent. The current models are dependent upon the assumption of average migratory timing of the Clockwork chum stocks. In-season models based upon average migratory timing will under or over-forecast population abundance's because of run timing variability. Recent analysis by Zheng and Mathisen (1998) that incorporates a run timing variable found greatly improved run size forecasts for southeastern Alaska pink salmon. They found that incorporating sex ratios with their best performing run model improved forecasts by 30% over the best model without sex ratios. We have been collecting sex ratio data for chum Clockwork stocks since 1993 and preliminary analysis indicates that there is a correlation between sex ratios and run timing as observed by the

Johnstone Strait chum test fishery vessels. Therefore we recommend that further analysis be considered to incorporate sex ratio data into the in-season run size models.

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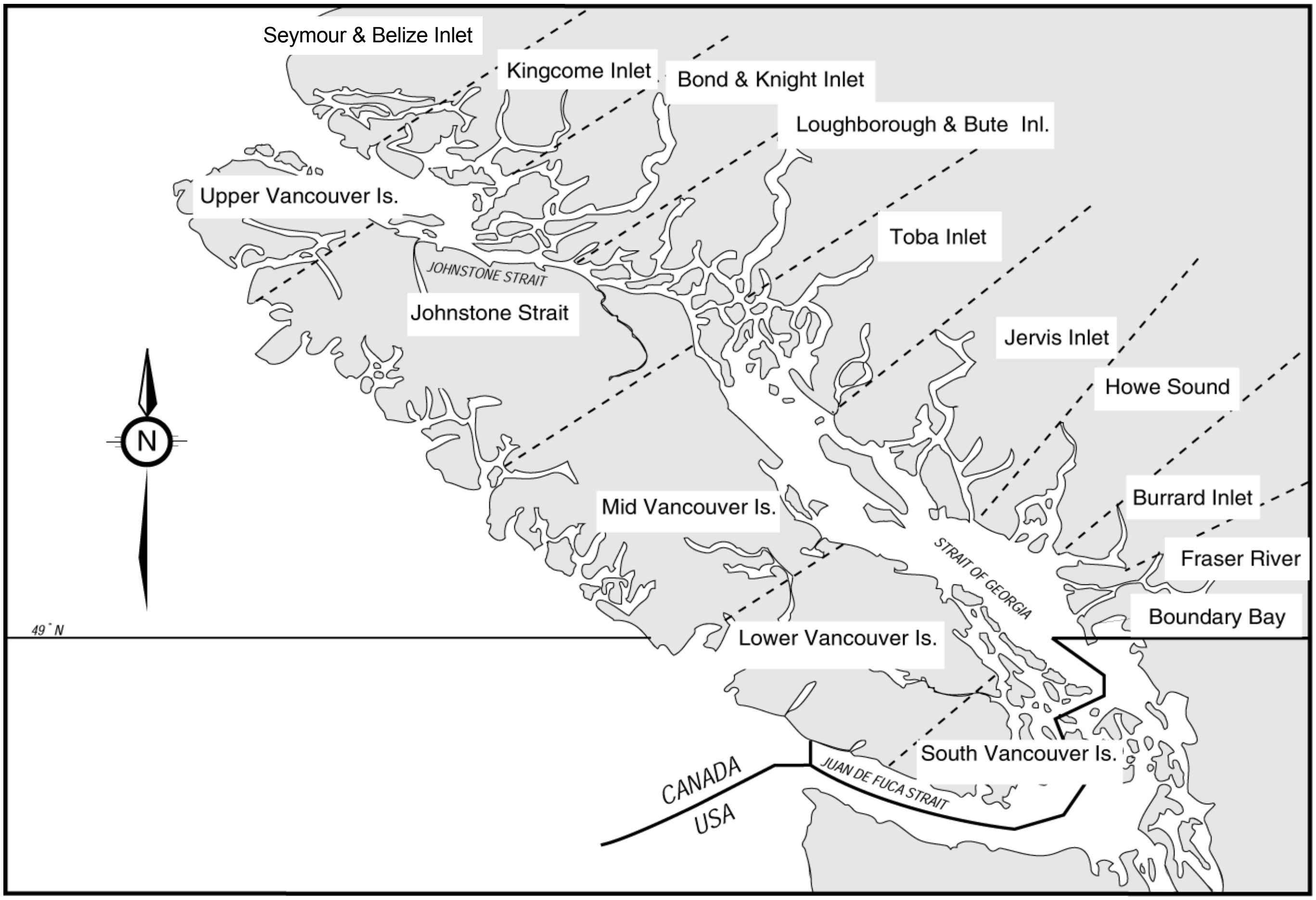



Figure 1.1. The fifteen major geographic regions for Inner South Coast Chum Salmon stock groups. Chum stocks in Seymour and Belize Inlets (Area 11) and those below Saanich Inlet (Areas 19 and 20) in South Vancouver Island are not included in the Inner Study Area or Clockwork Management Strategy.

Figure 1.2. Trends in catch and escapement for Clockwork chum stocks from 1953 to 1997.

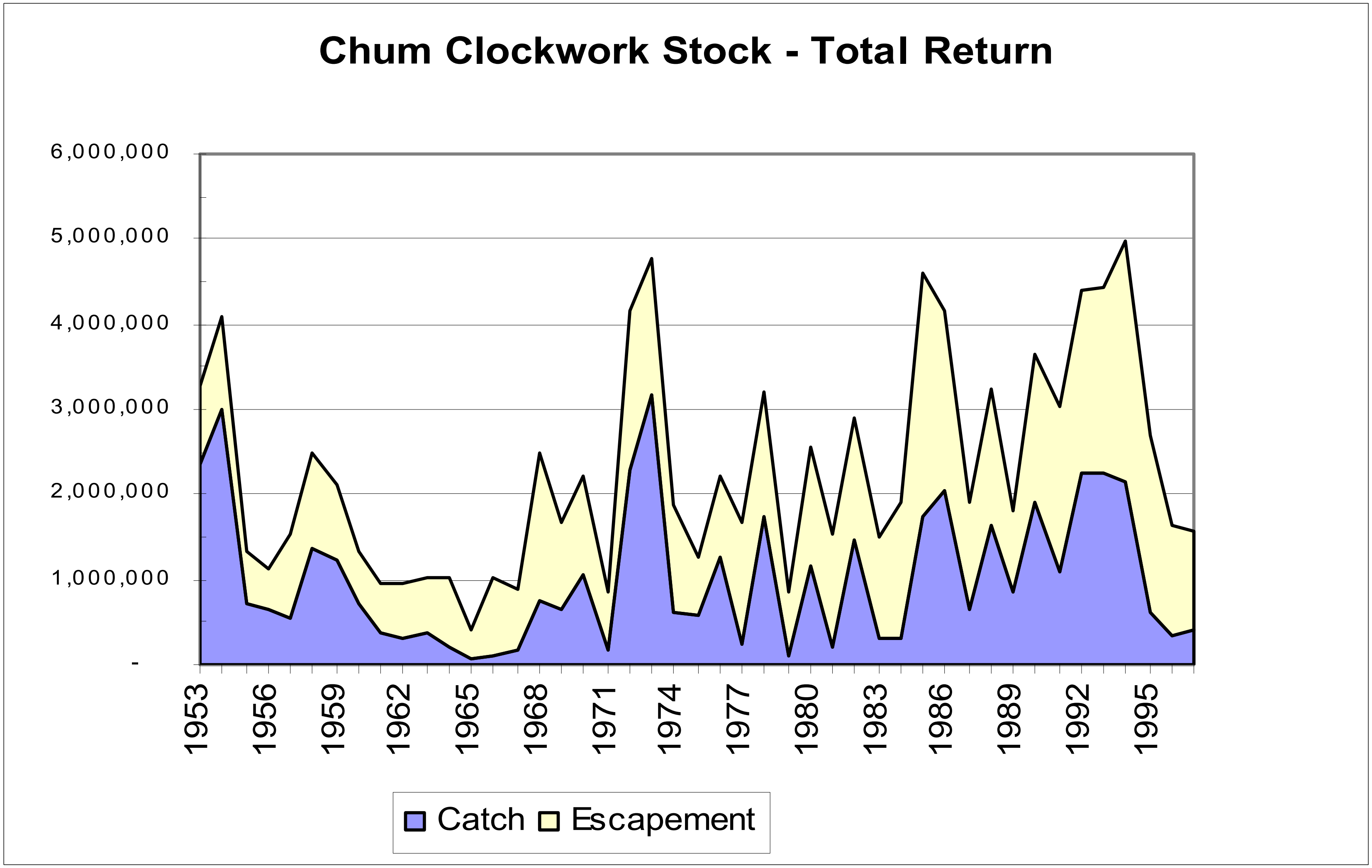
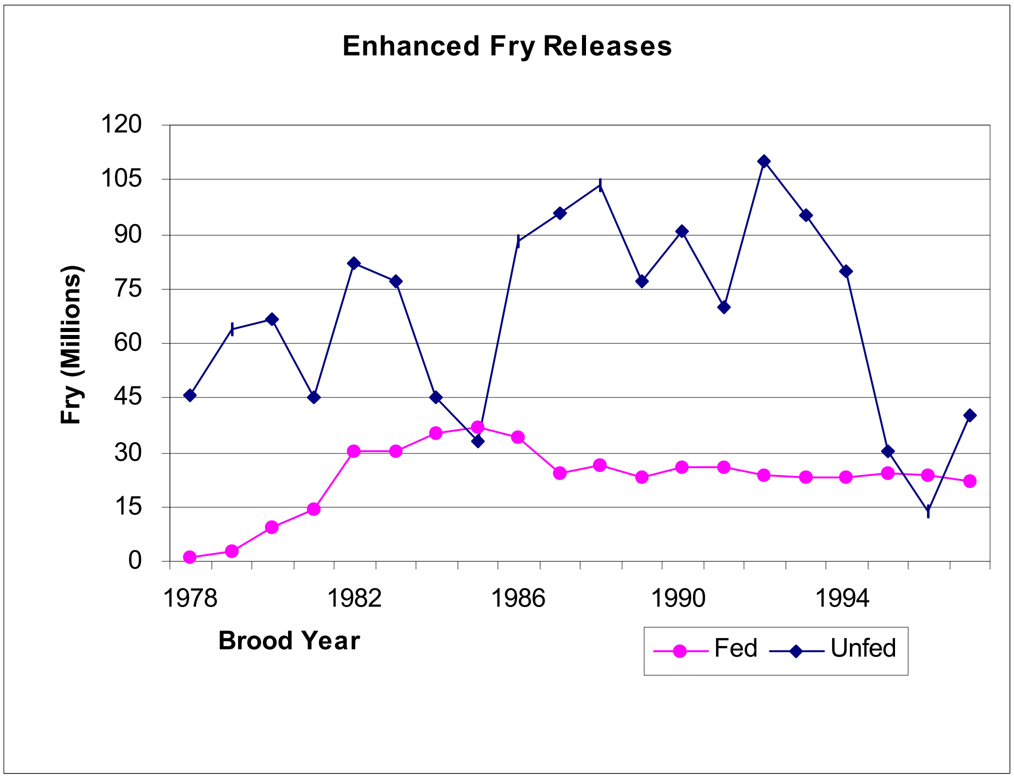


Figure 3.1 Inner South Coast enhanced fed and unfed juvenile releases (1979-1997 Brood)



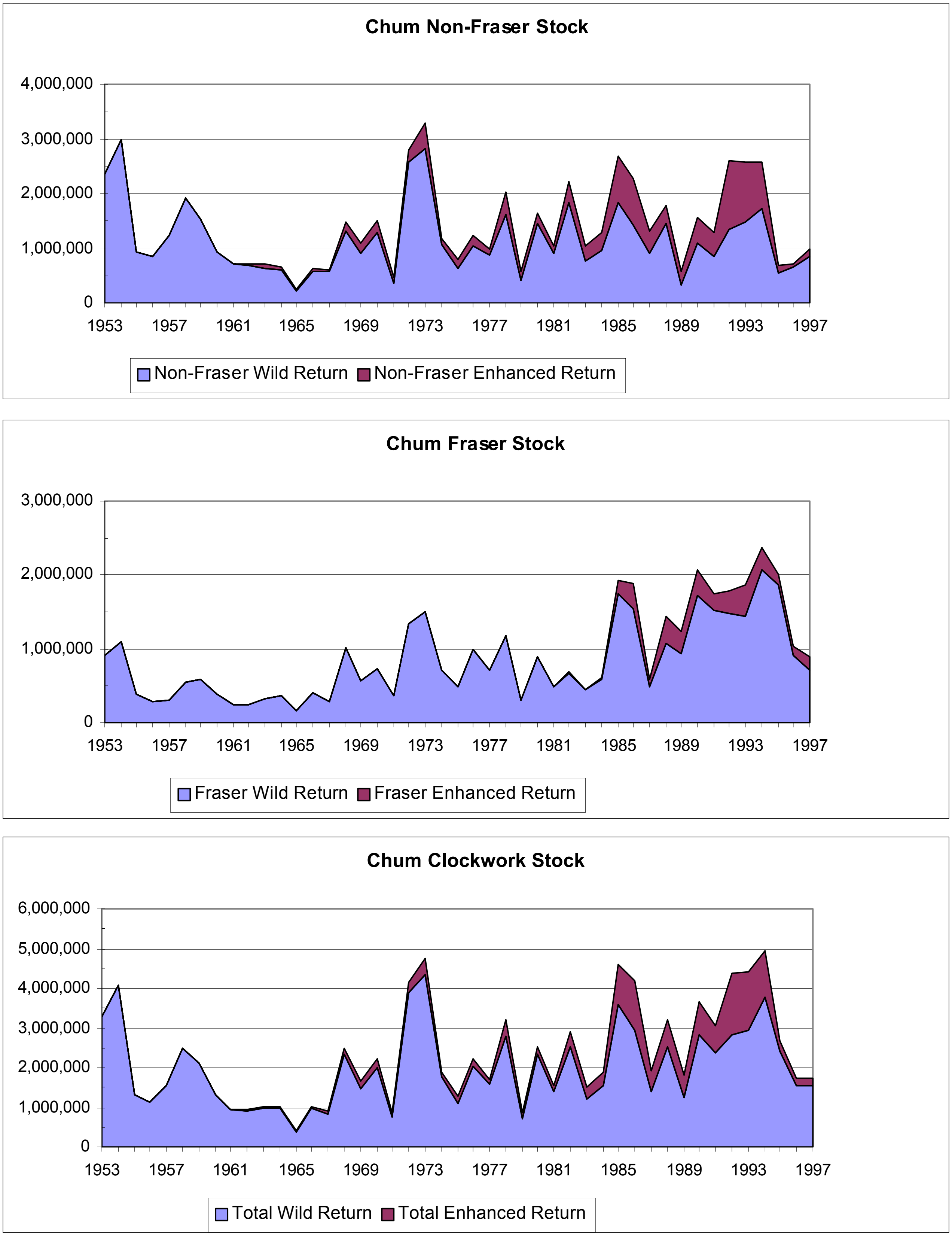



Figure 3.2 Inner South Coast Non-Fraser and Fraser wild and enhanced total chum returns (1953-97)

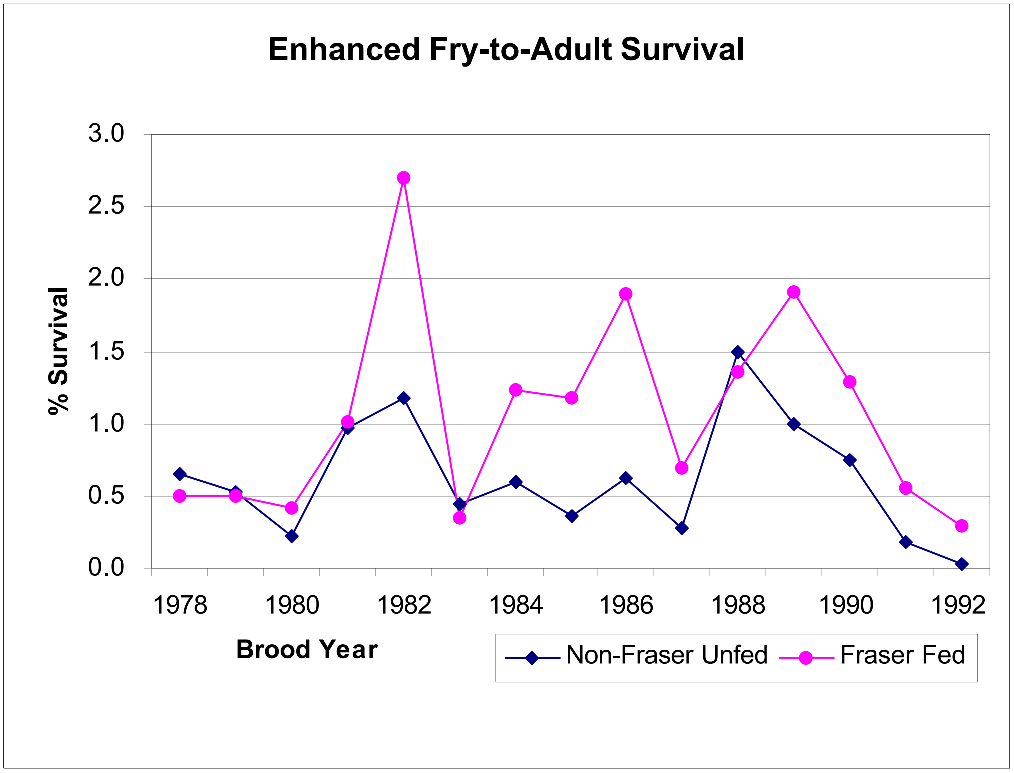



Figure 3.3 Fry-to-adult survivals for Inner South Coast enhanced fed and unfed chum (1978-1992 Broods)

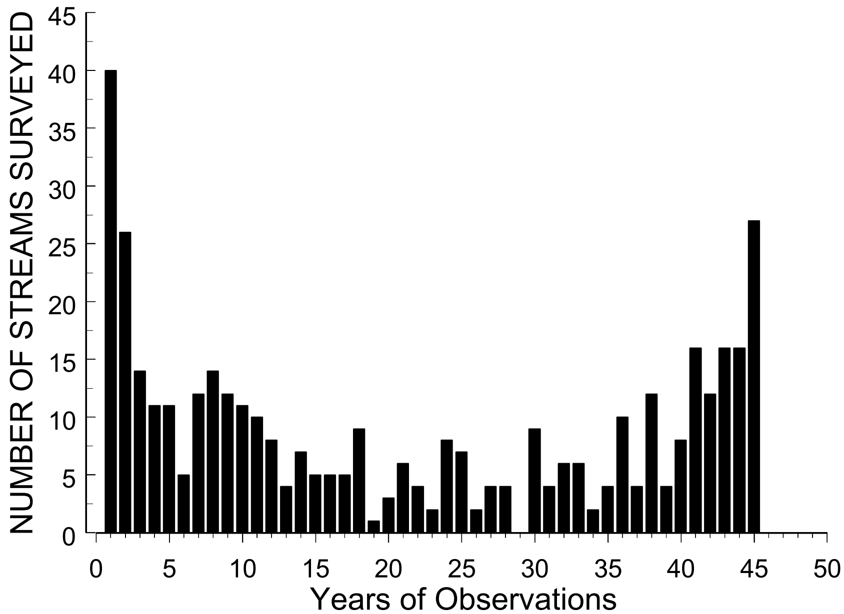



Figure 4.1 Distribution of the number of observations for Inner South Coast Chum salmon stocks from 1953 to 1997. Maximum number of observations is 45.

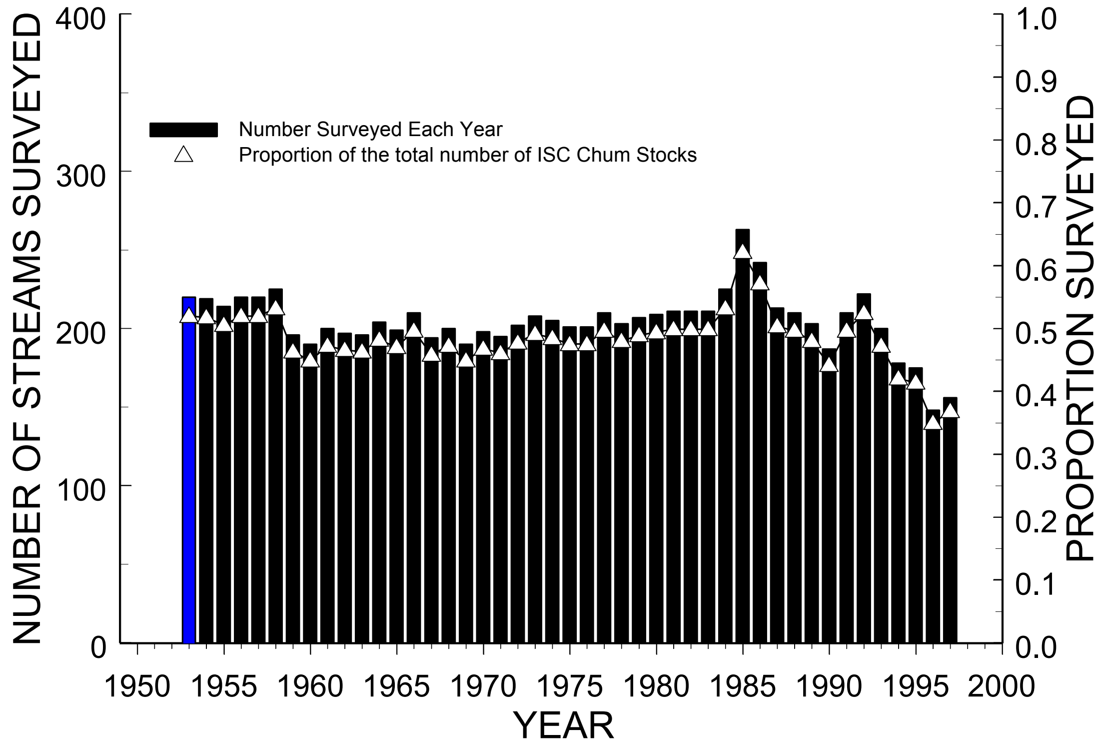



Figure 4.2 History of escapement surveys for Inner South Coast chum salmon from 1953 to 1997. Bar graph represents the number of streams surveyed each year. Line graph is the proportion of the total number (423) chum salmon stocks in the Inner South Coast with at least one chum salmon escapement estimate in the Salmon Escapement Database.

Figure 4.3 Relationship between total escapement contributed by each stock with at least one chum salmon escapement estimate in the Salmon Escapement Database and the total number of Inner South Coast chum stocks (423) for 1953-59 and 1990-97.

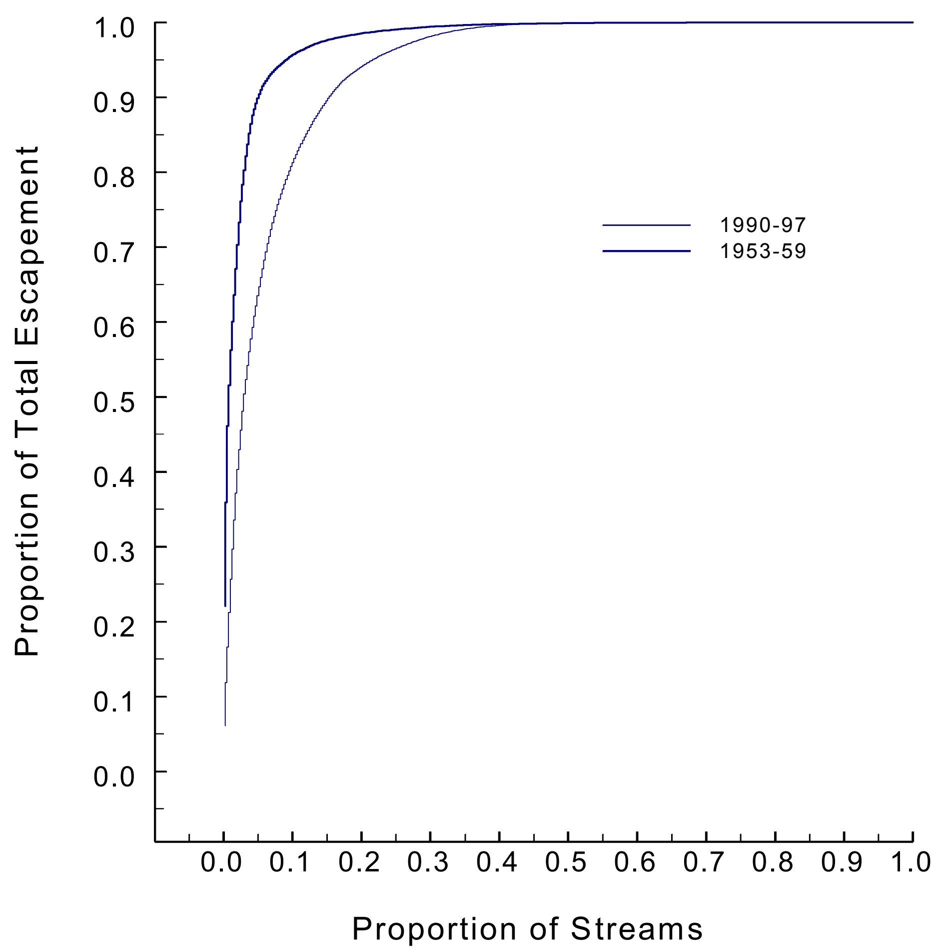
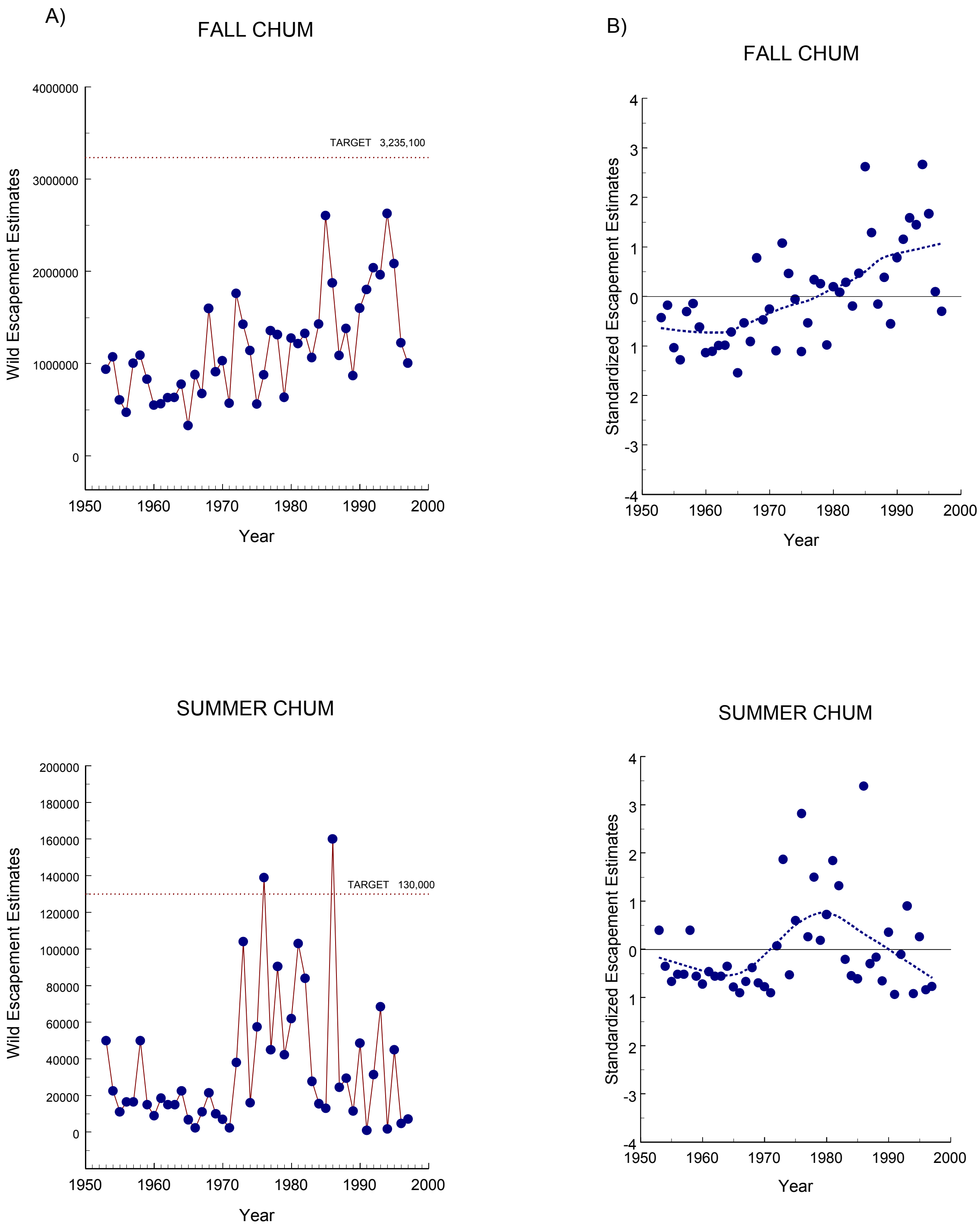


Figure 4.4 A) Wild escapement and B) standardized escapement trends for Inner South Coast Chum Salmon. Wild target escapement levels are shown for each region and the estimated wild capacities are shown for most regions. Zero line on B) represents the grand mean for each geographic area from 1953 to 1997. Dashed line is a lowess-smoothed curve.



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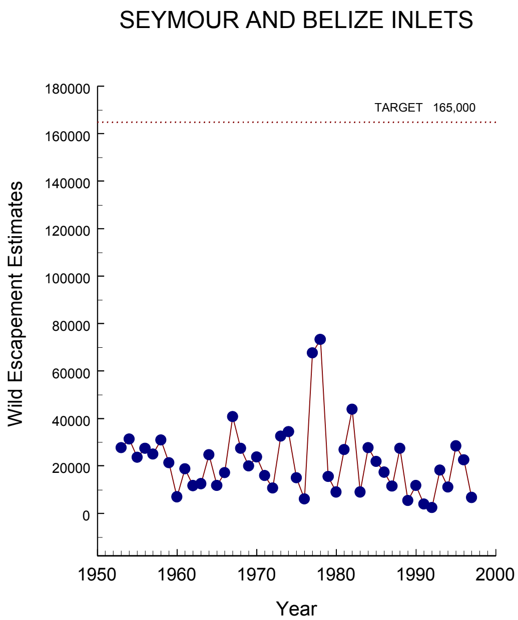


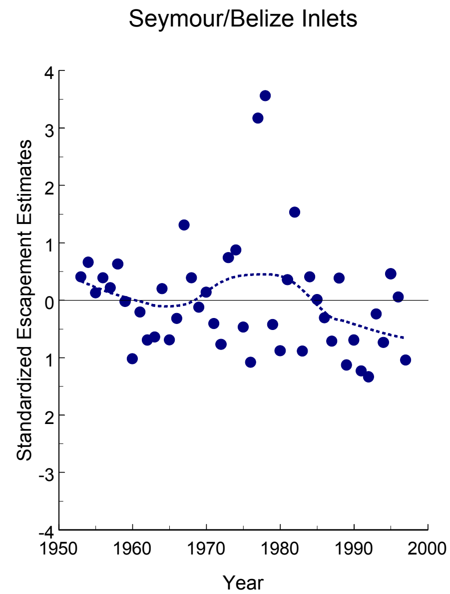


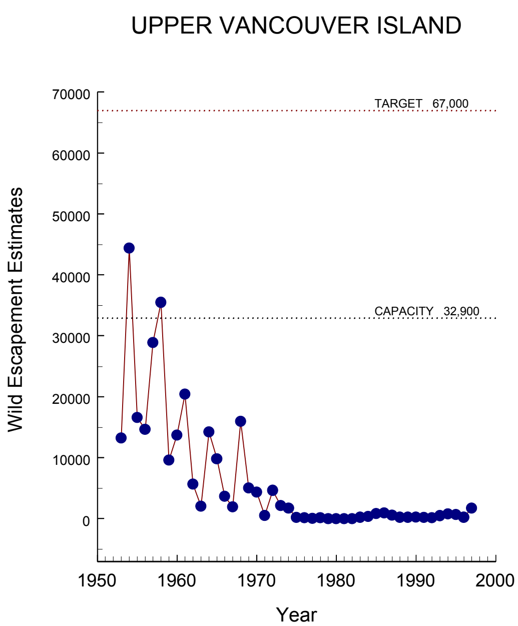


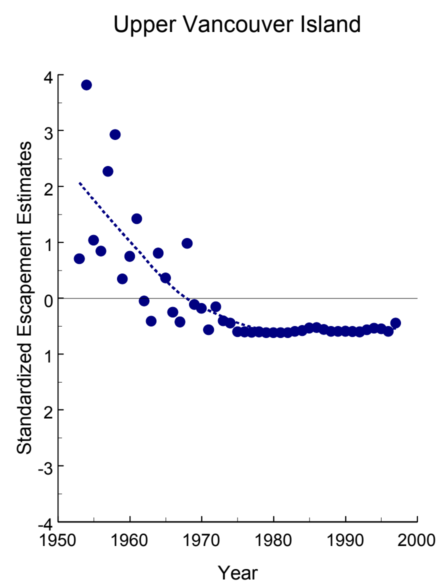

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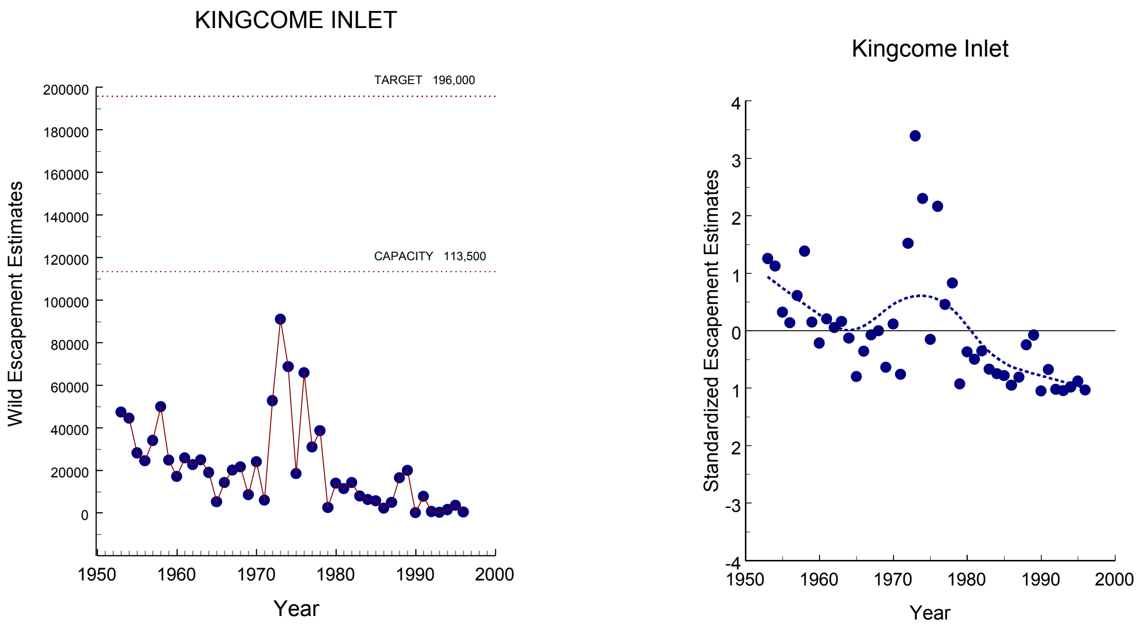


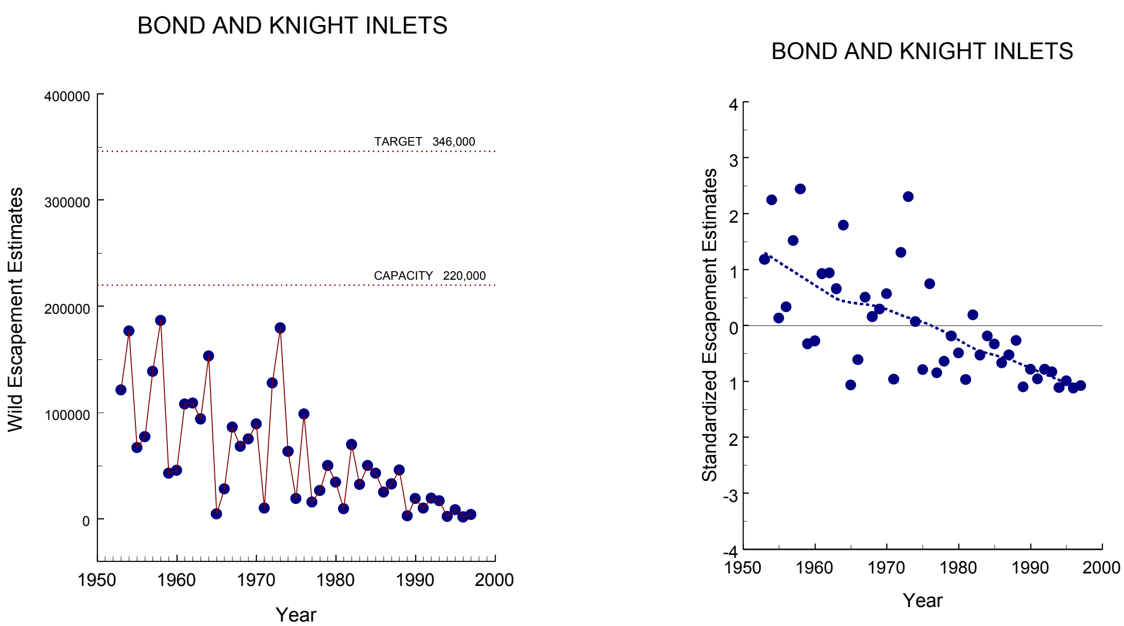

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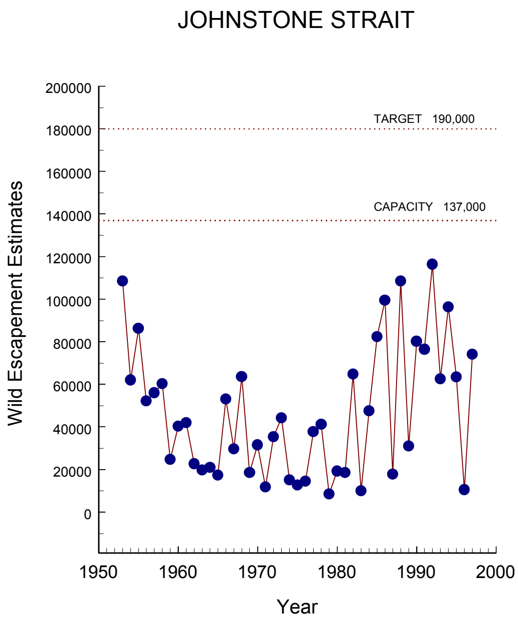


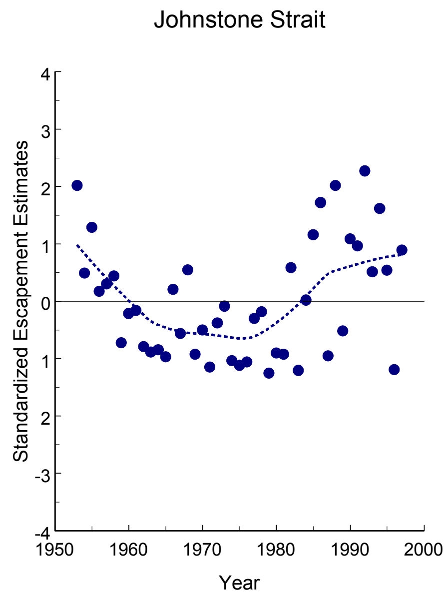


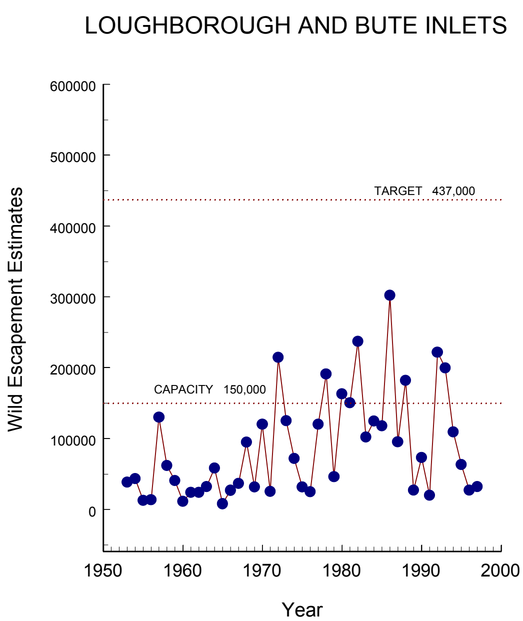


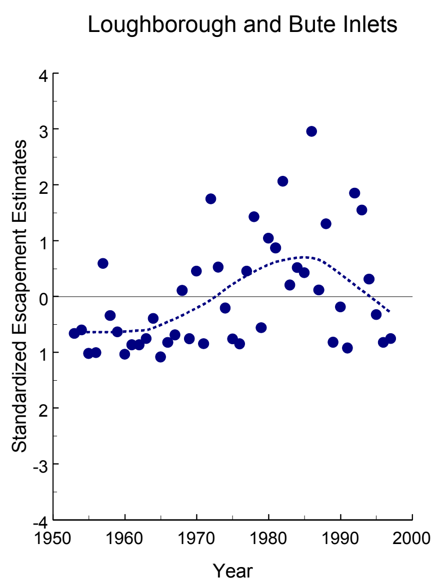

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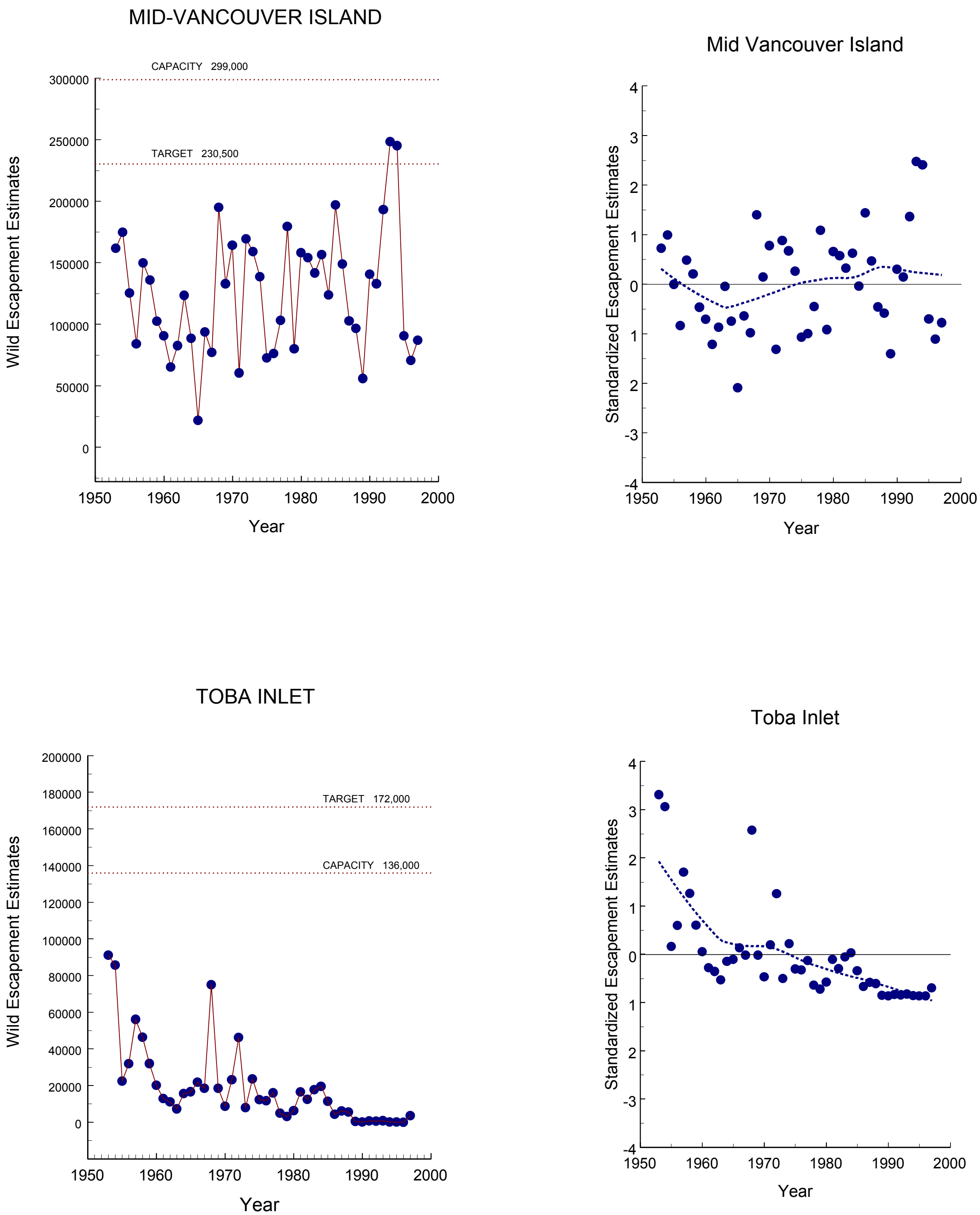

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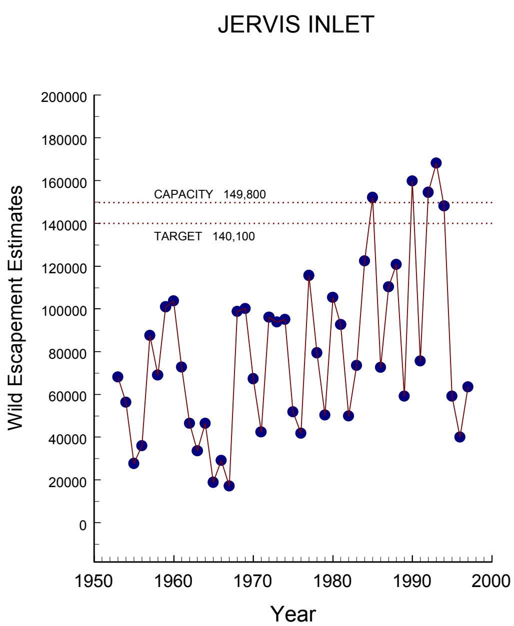


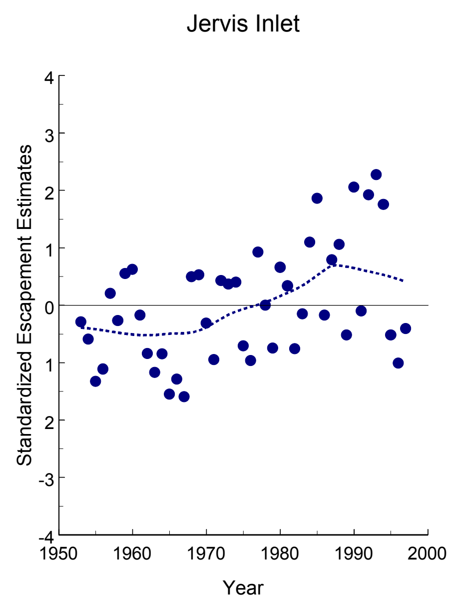


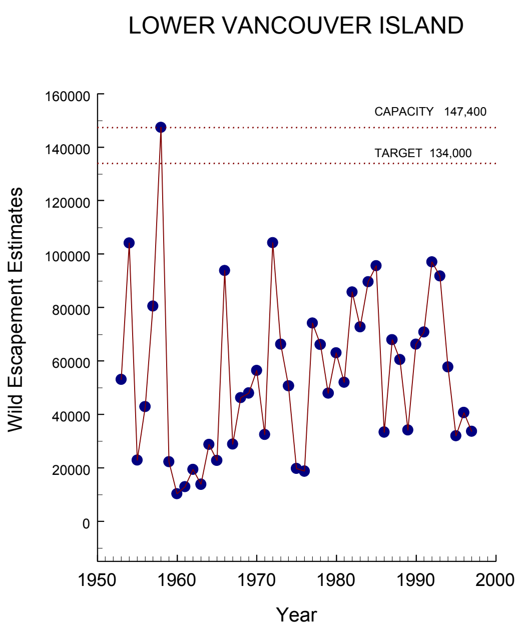


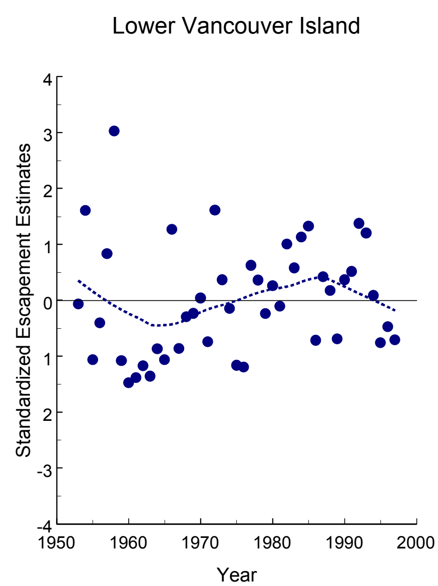

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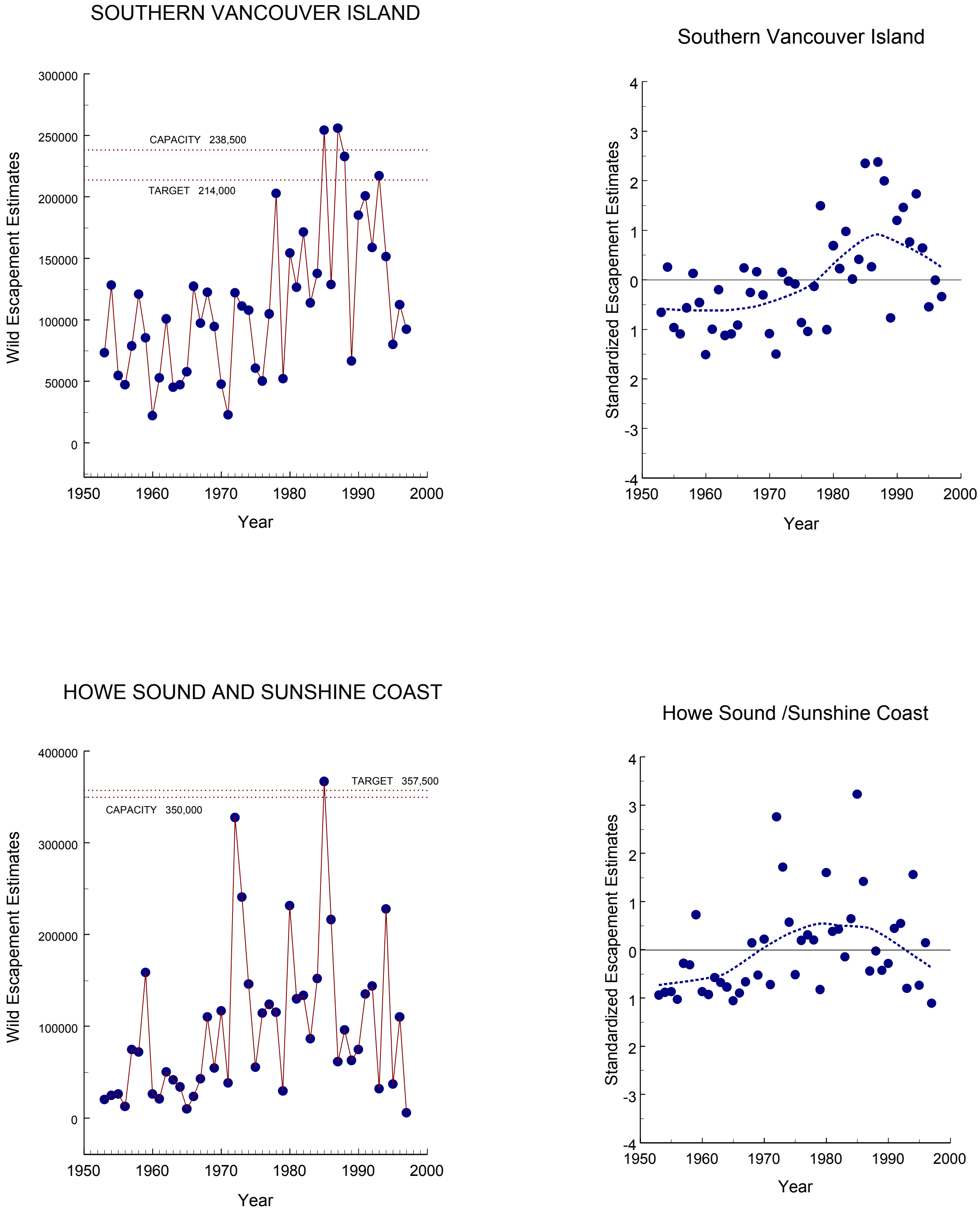

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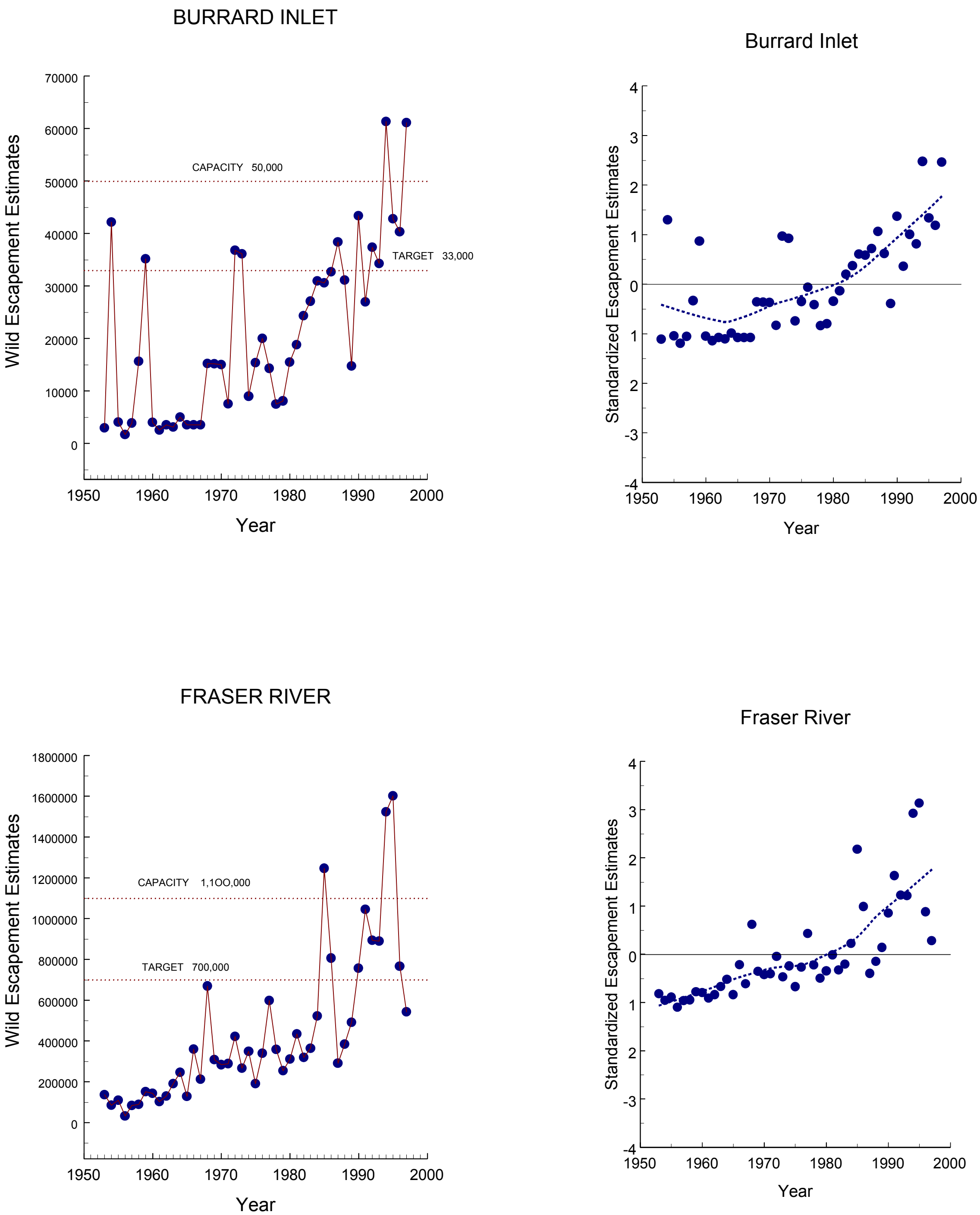

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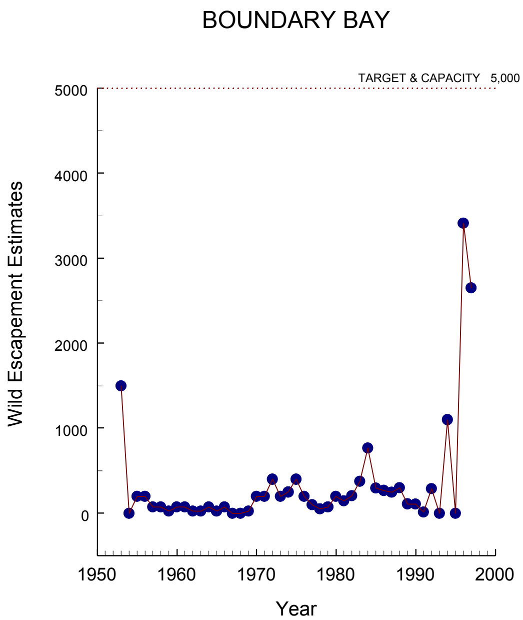


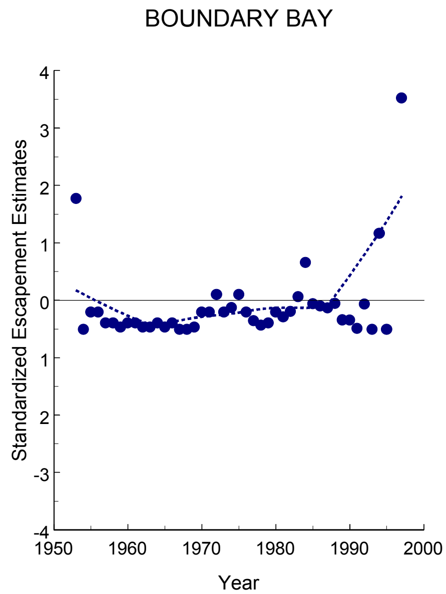
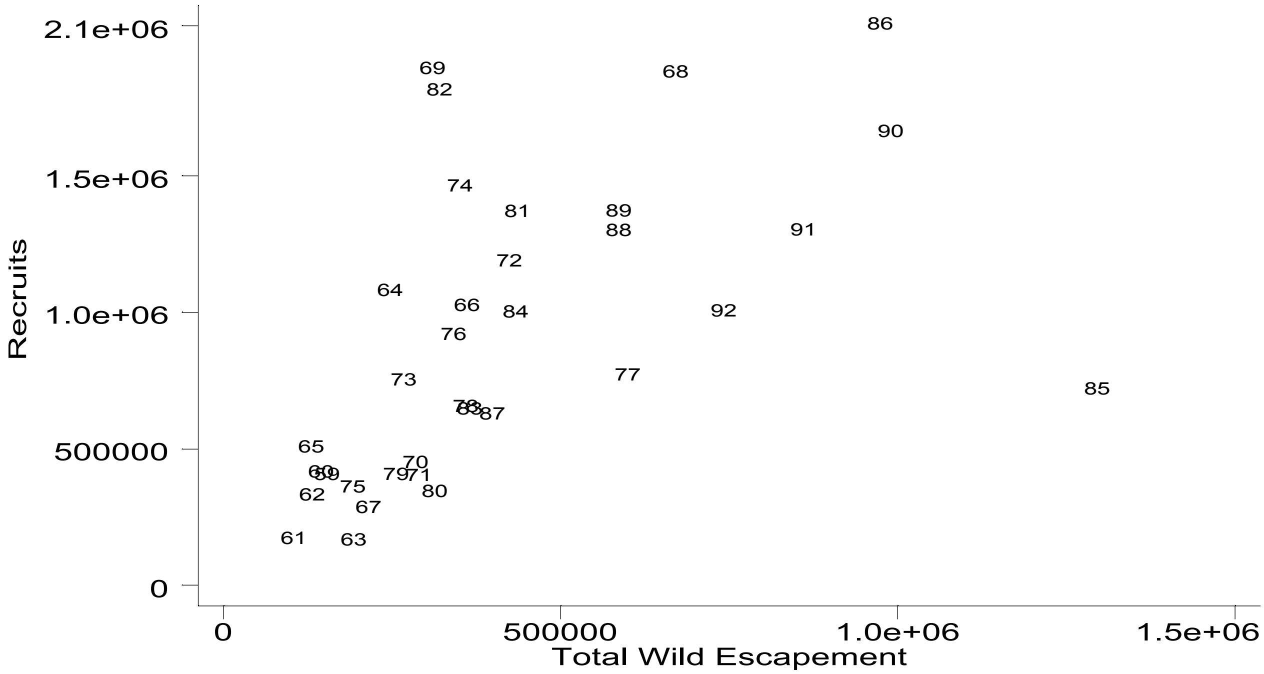



Figure 5.1




Fraser R. Chum Total Recruits vs Total Wild Escapement

Figure 5.2

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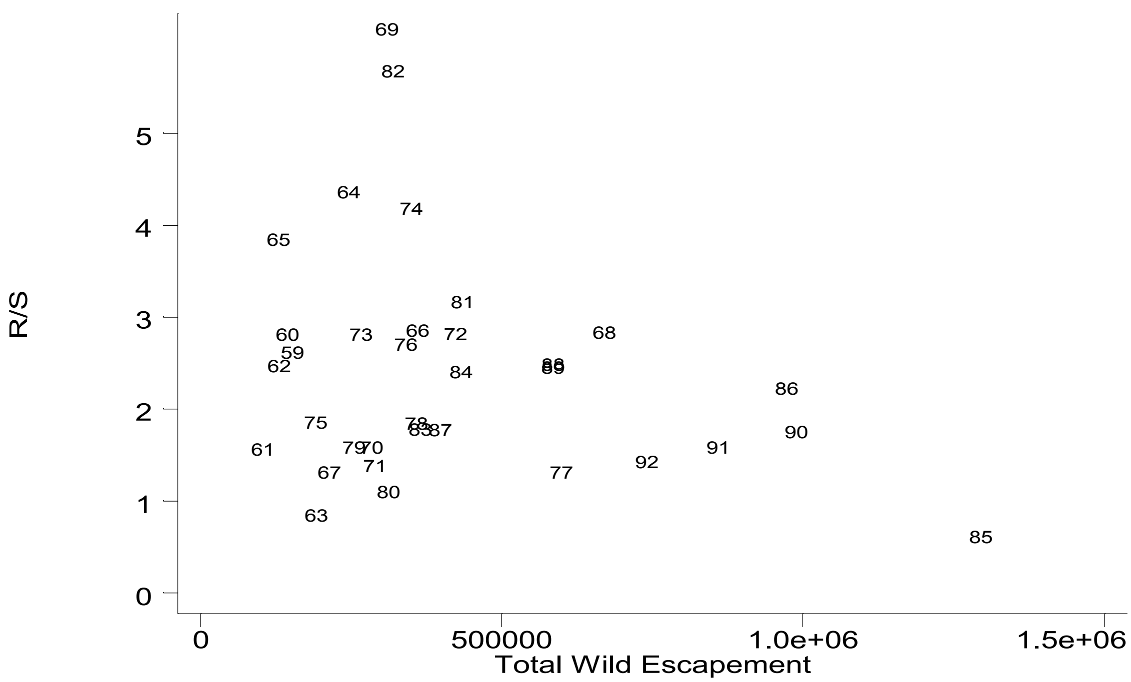
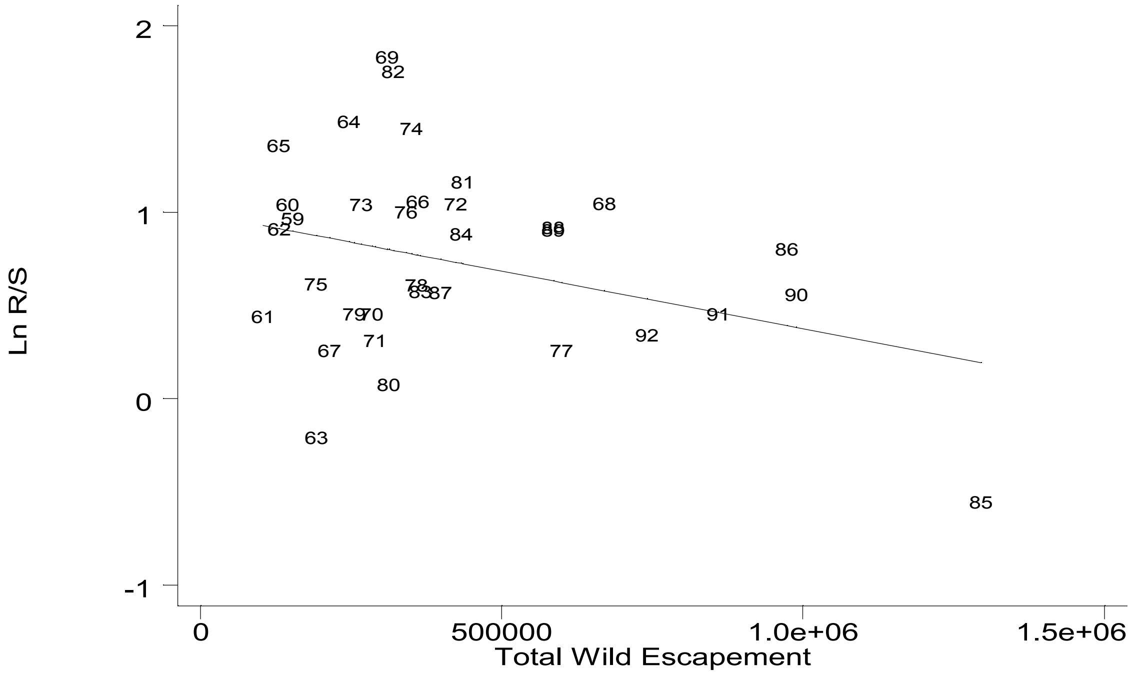


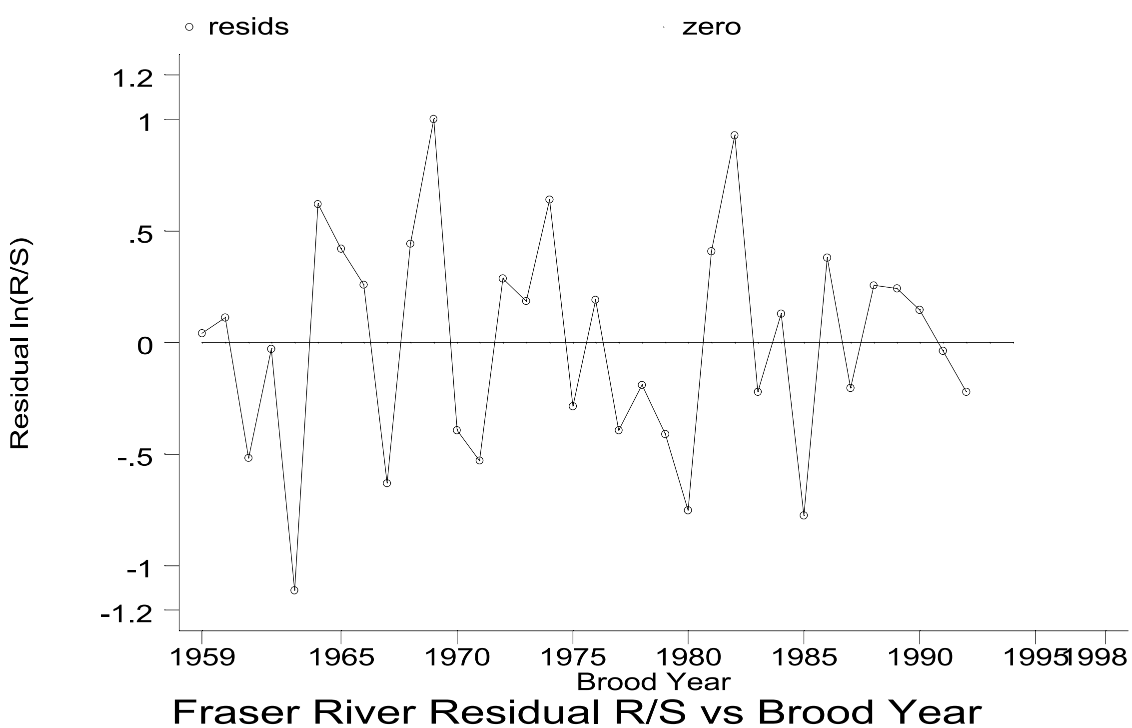

Fraser River Chum (R/S) vs Total Wild Escapement

Figure 5.3



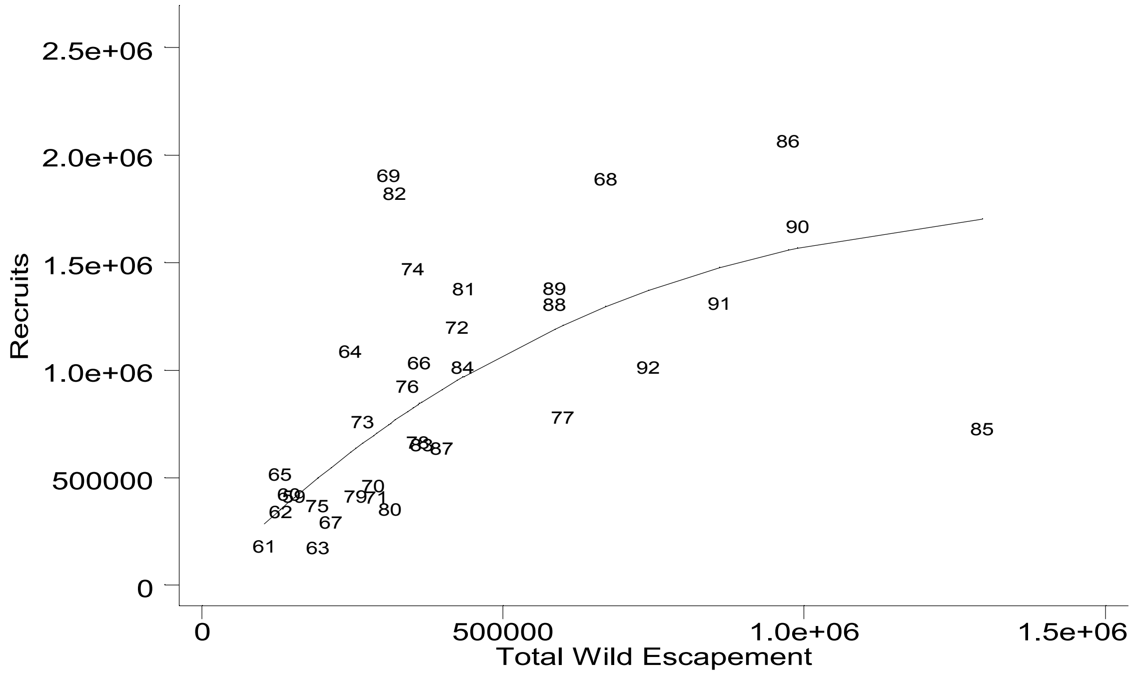

Fraser River Chum Ln(R/S) vs Total Wild Escapement

Figure 5.4



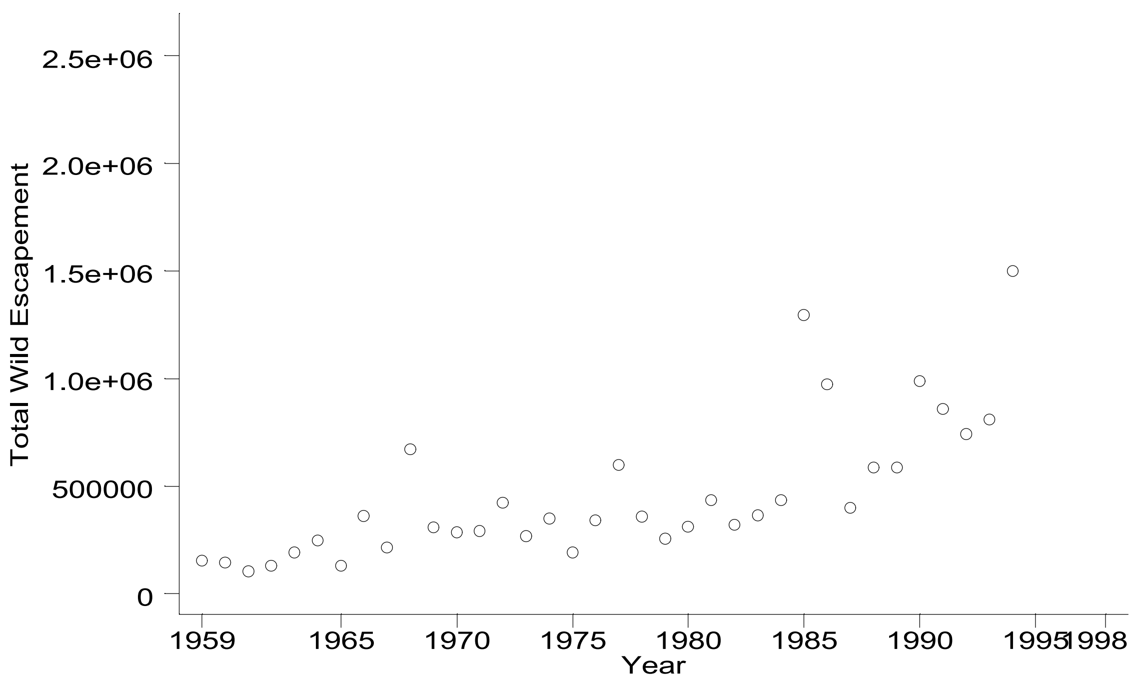

Fraser River Residual R/S vs Brood Year

Figure 5.5



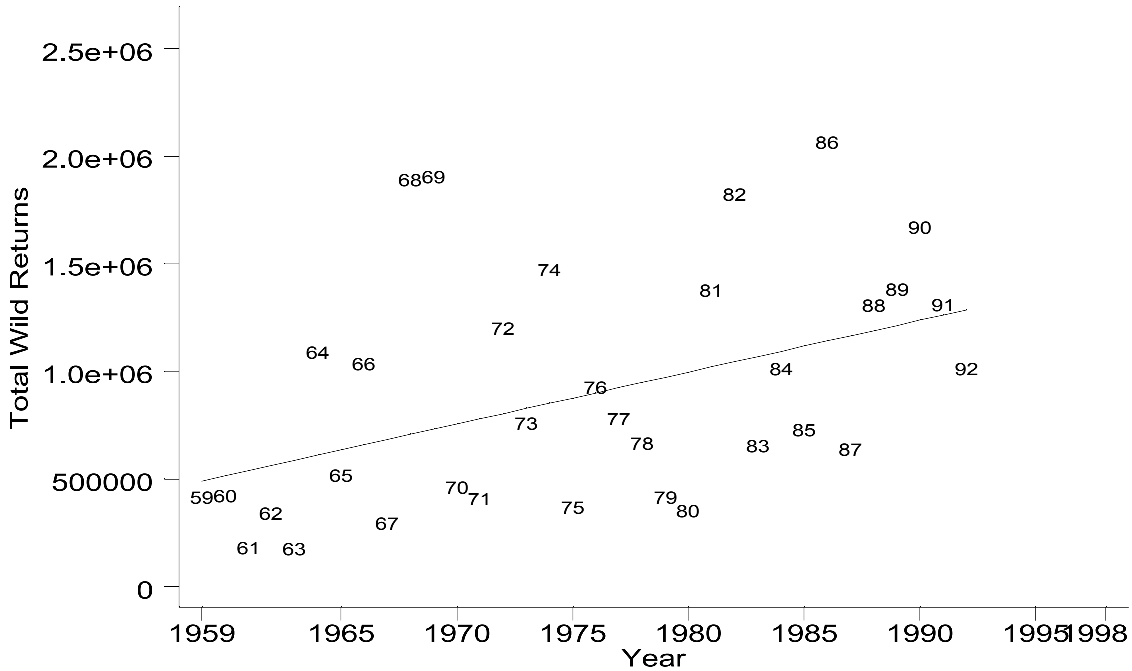

Fraser R. Chum Total Recruits vs Total Wild Escapement

Figure 5.6




Fraser R. Chum Total Wild Escapement vs Return Year

Figure 5.7




Fraser River Chum Total Wild Returns vs Year

Figure 5.8a

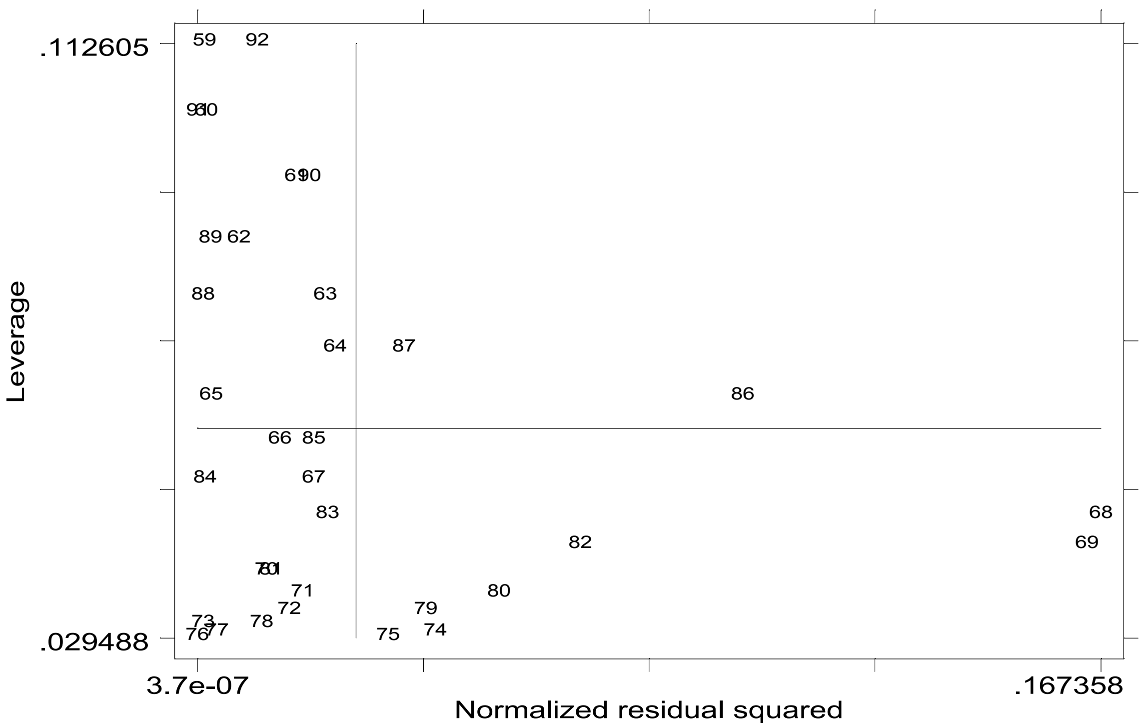



Figure 5.8b

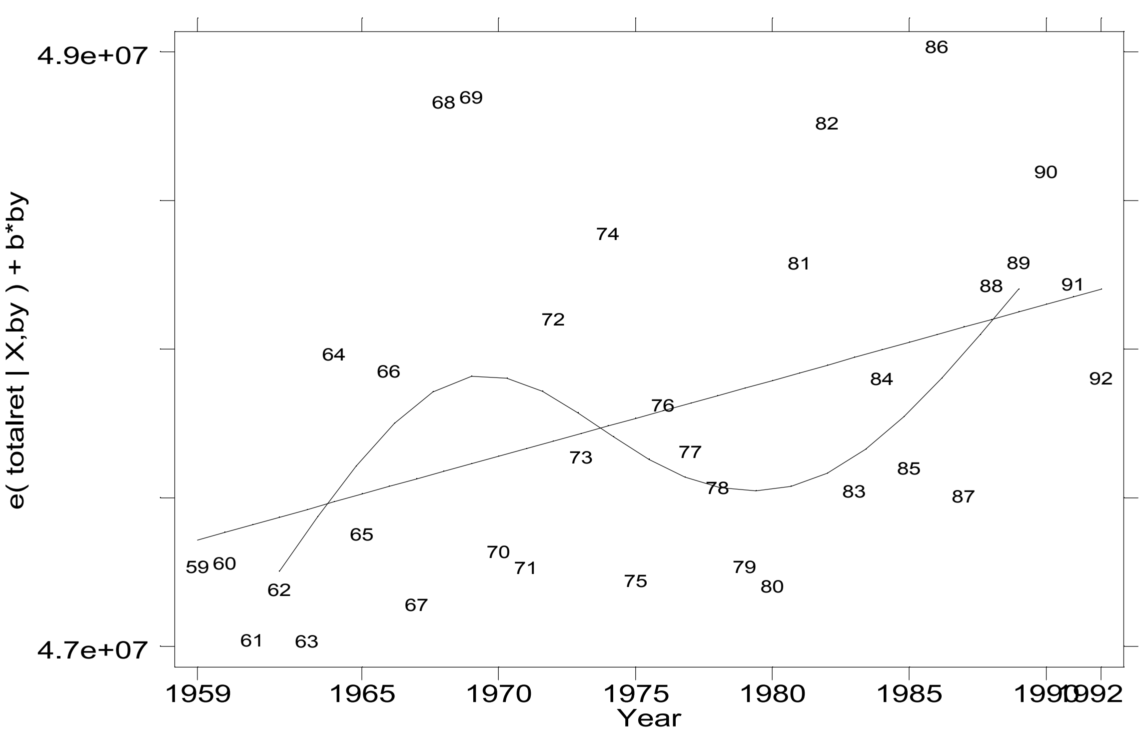
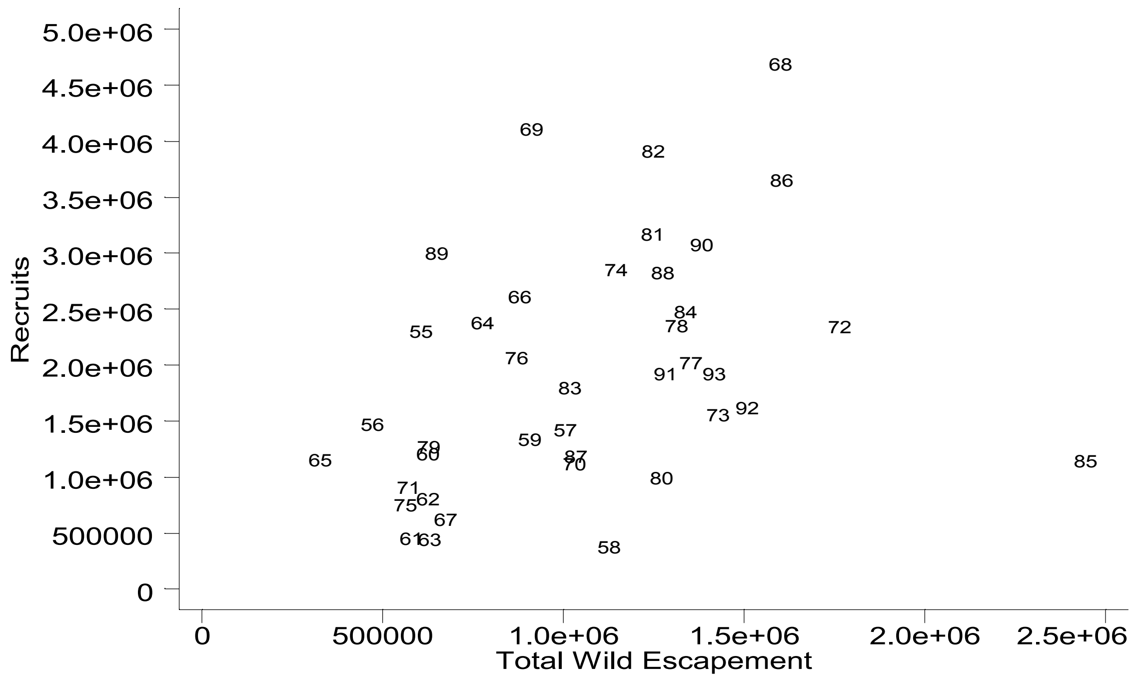
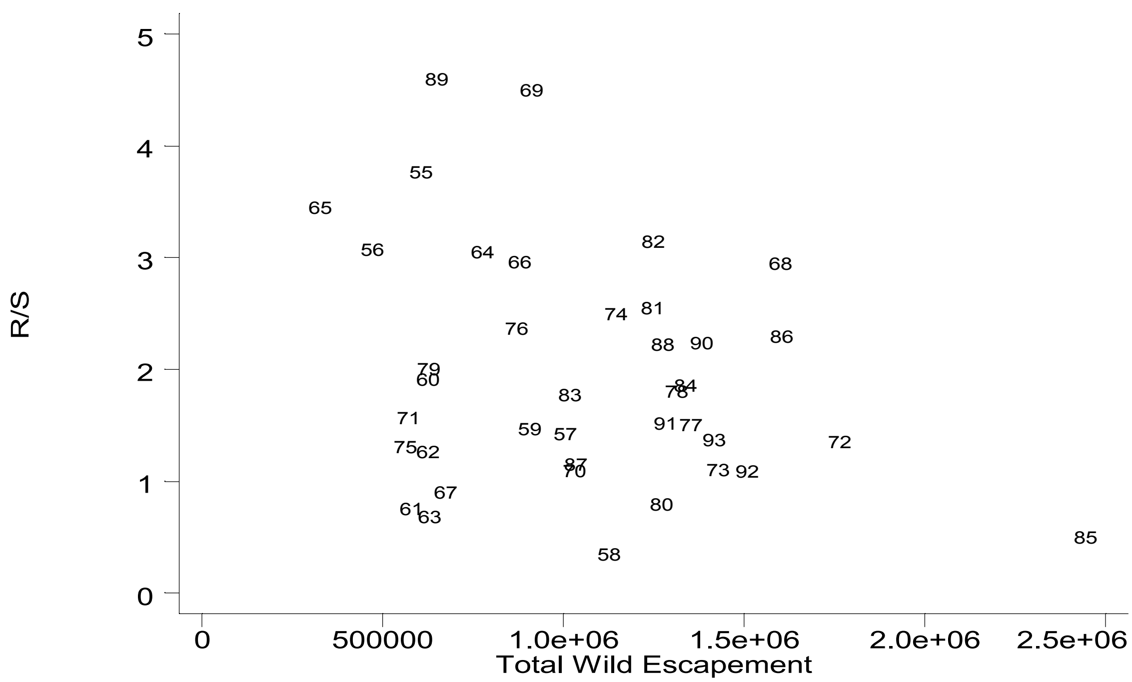


Figure 5.9



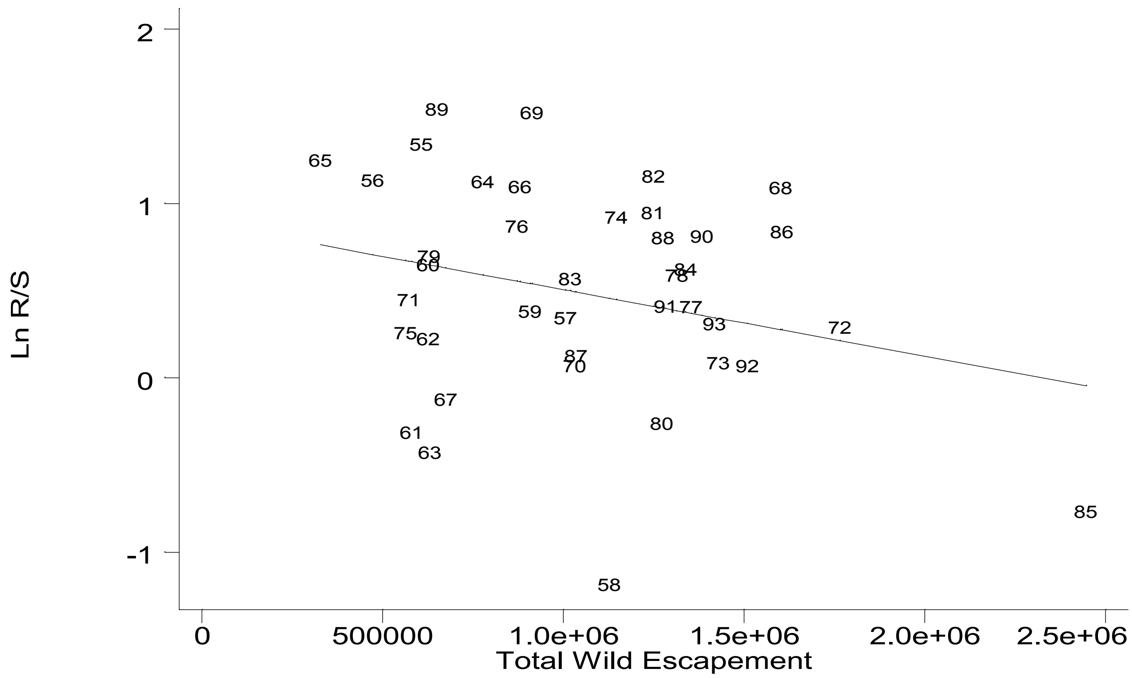

All Chum Total Recruits vs Total Wild Escapement

Figure 5.10



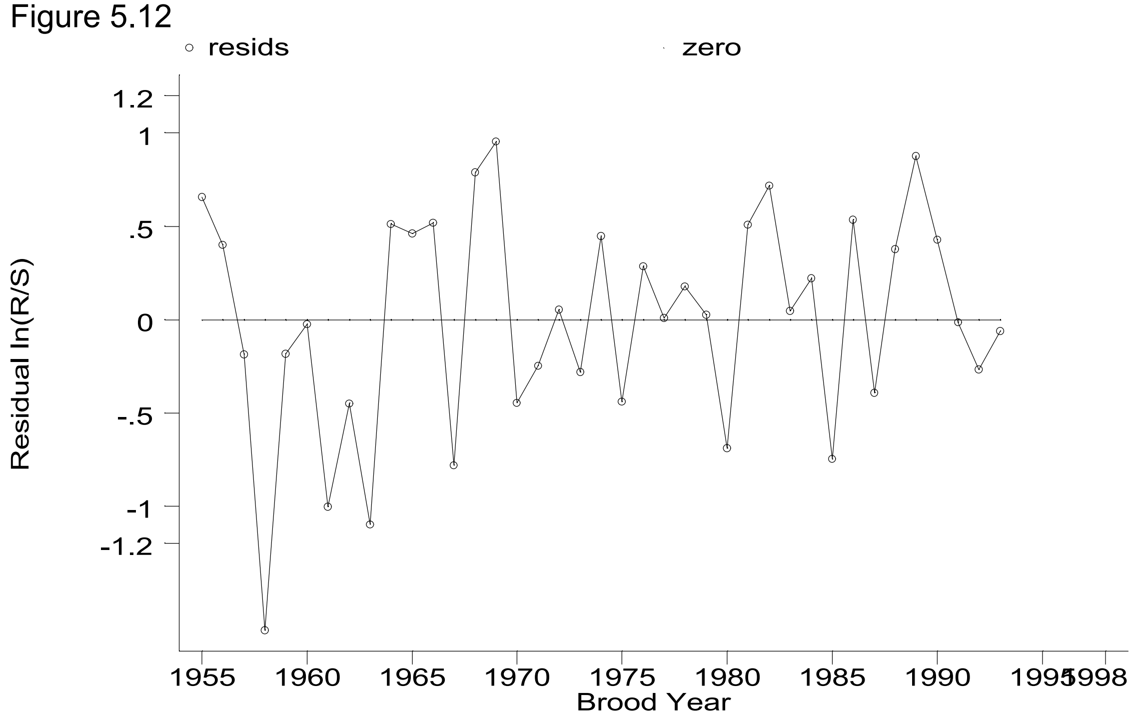

All Chum (R/S) vs Total Wild Escapement

Figure 5.11



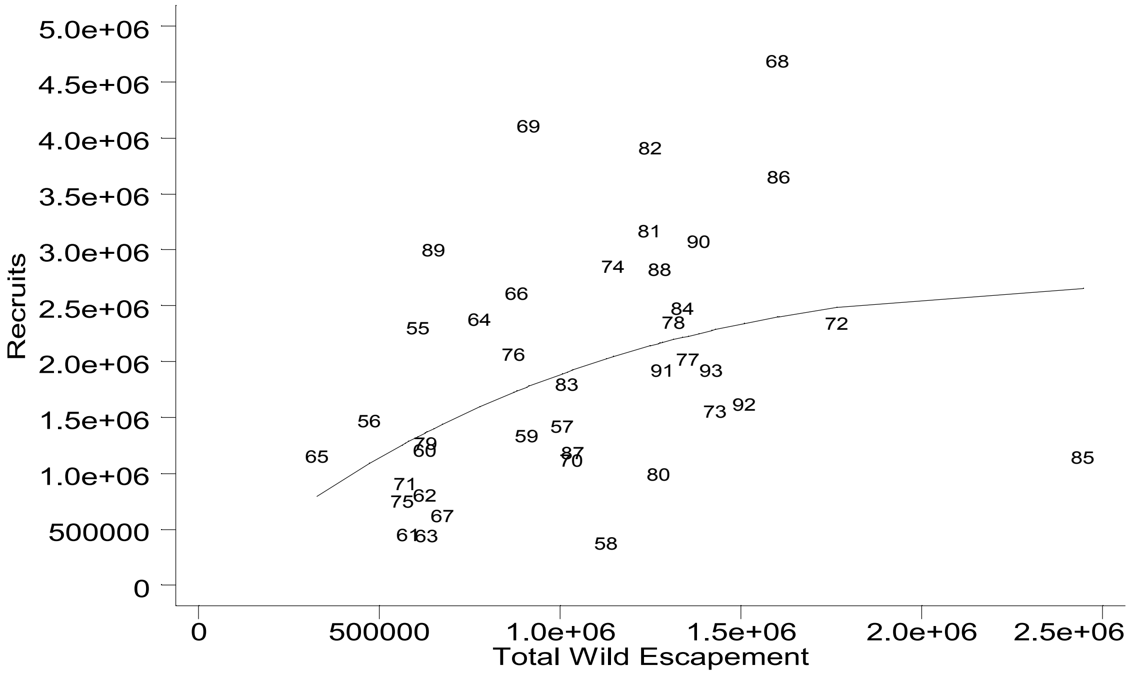

All Chum Ln(R/S) vs Total Wild Escapement

Figure 5.12




All Chum Residual R/S vs Brood Year

Figure 5.13

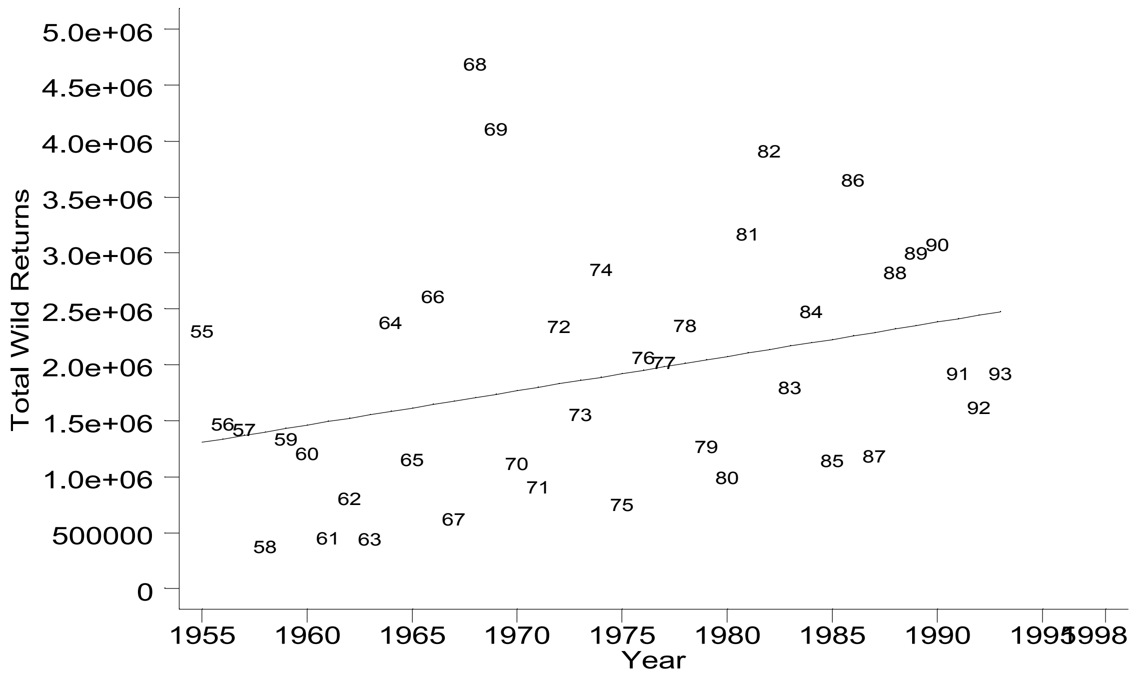



All Chum Total Recruits vs Total Wild Escapement

Figure 5.14


All Chum Total Wild Escapement vs Return Year

Figure 5.15




All Chum Total Wild Returns vs Year

Figure 5.16a

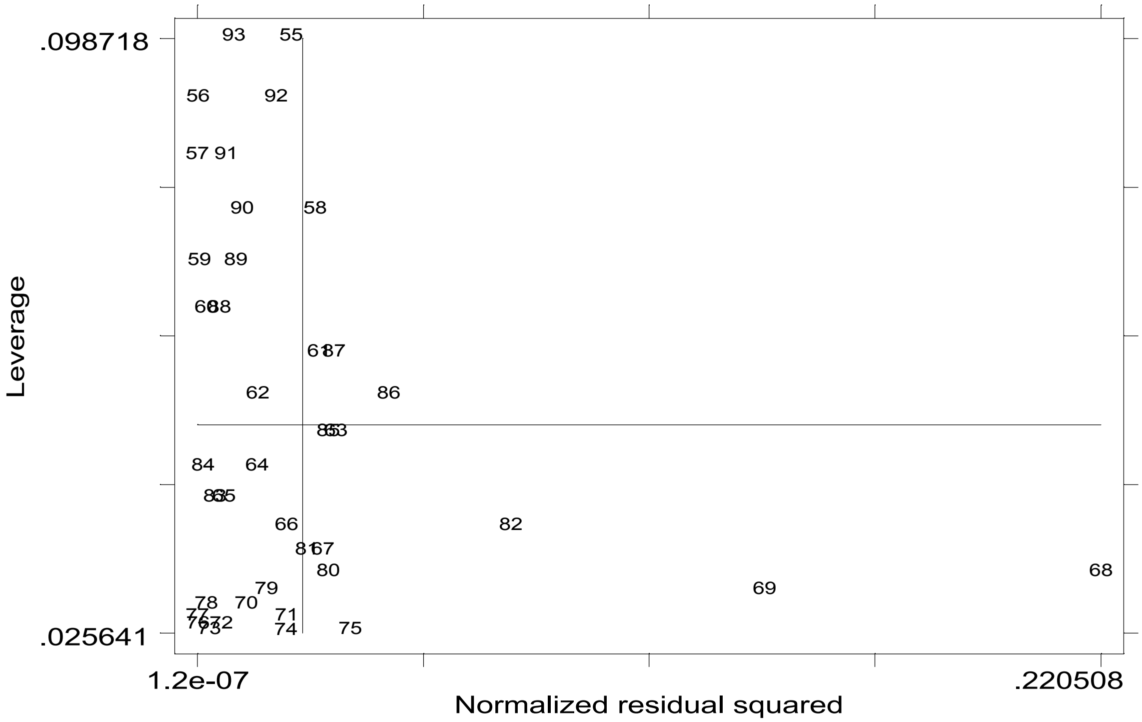



Figure 5.16b

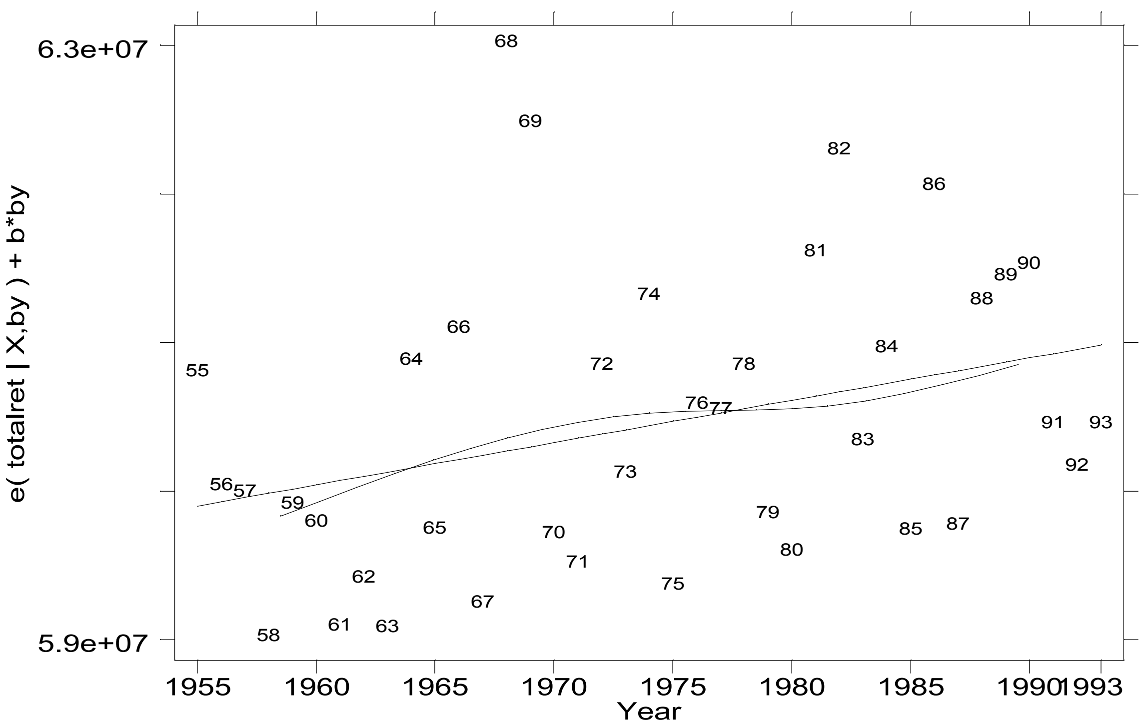


Figure 5.17. Trend in Clockwork chum exploitation rate from brood year 1953 to 1993.

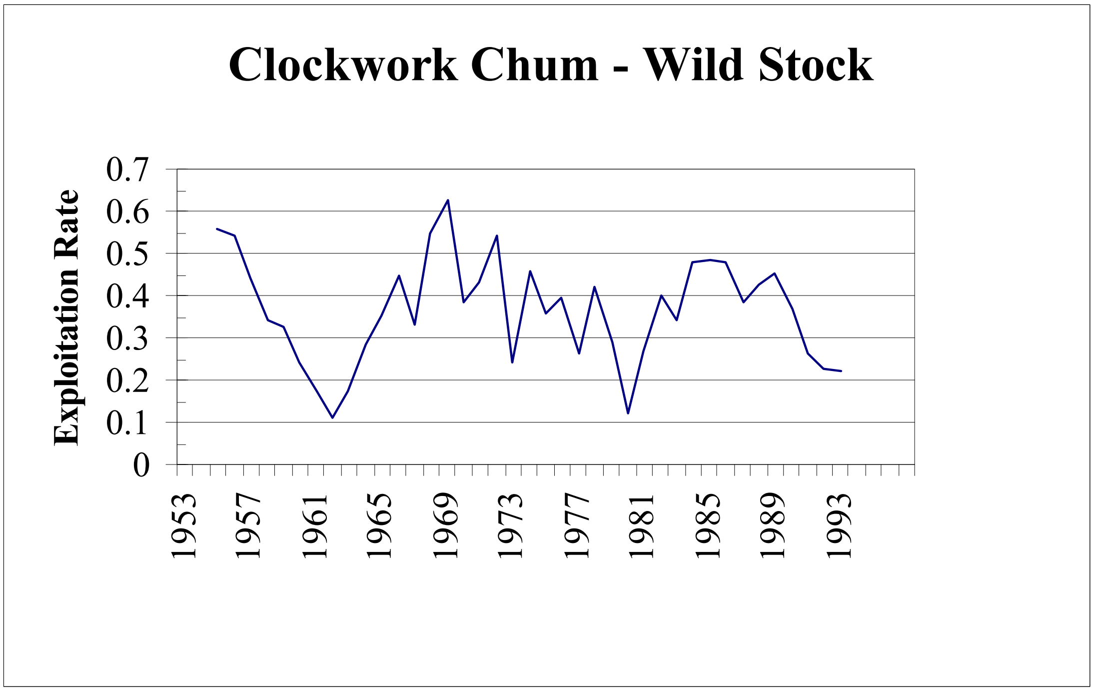
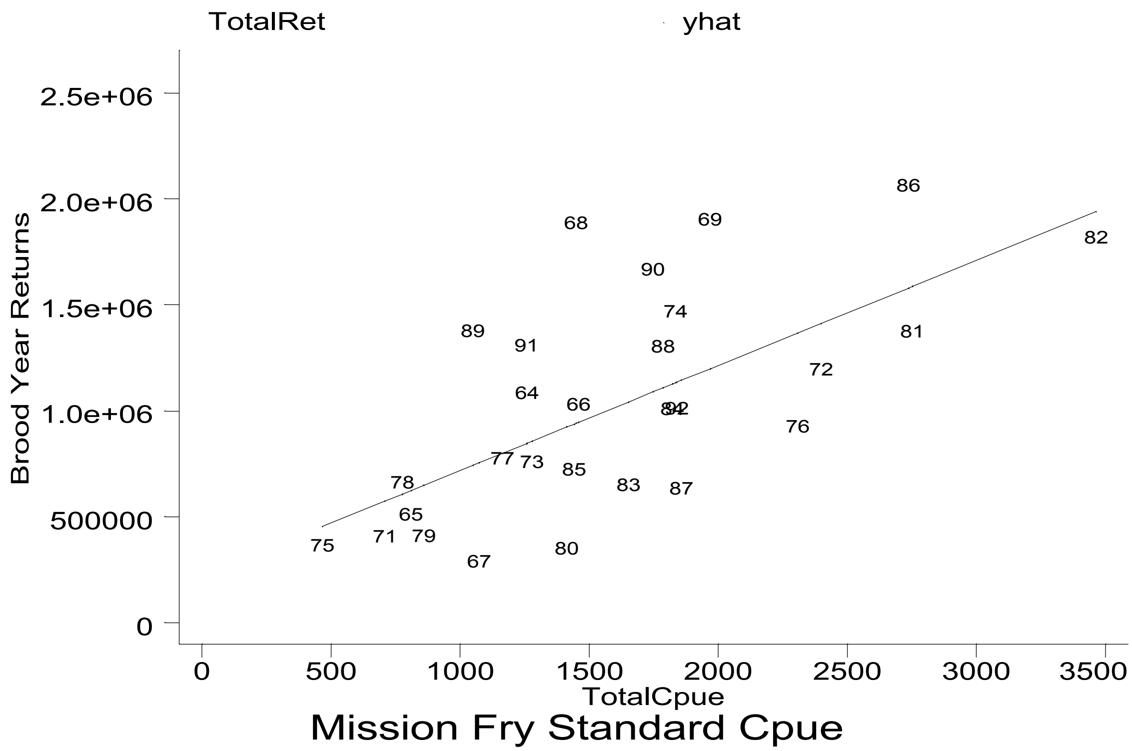


Figure 6 Relationship between an index of chum fry abundance migrating down the Fraser River measured at Mission, B.C. and brood year returns.



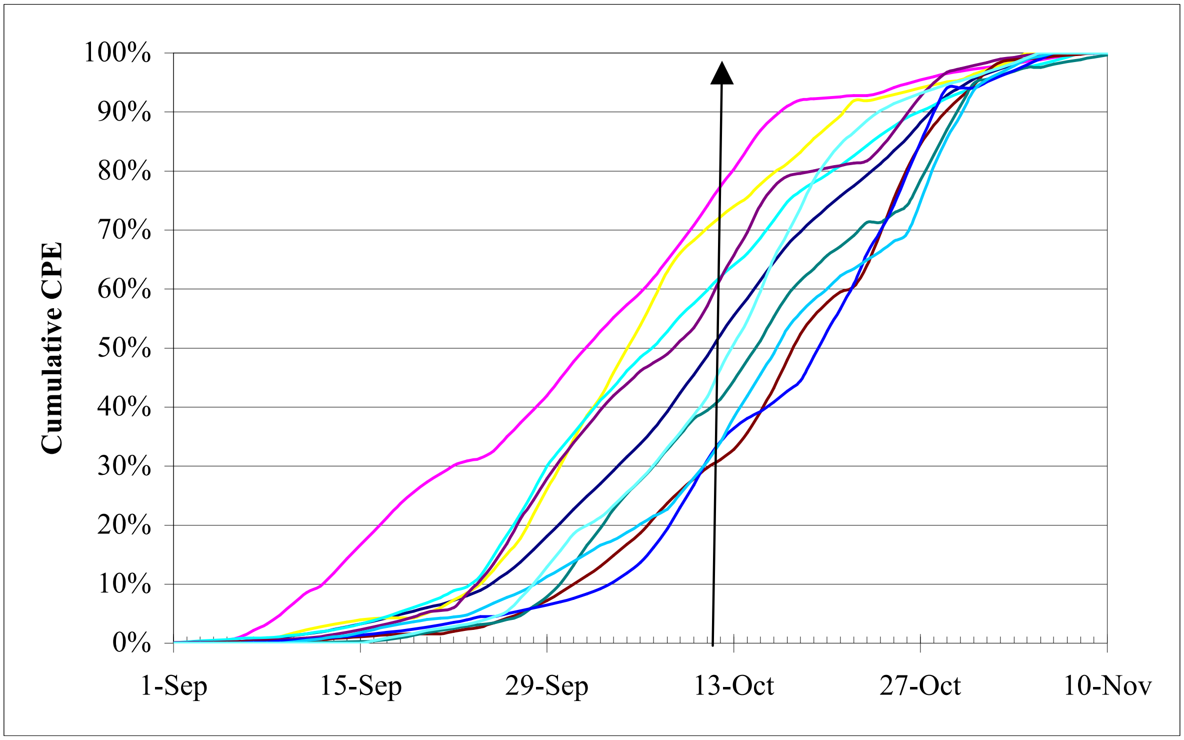



Figure 7.1. Clockwork chum salmon run timing past Johnstone Strait test fishery calculated from cumulative test fishing CPUE for years 1988 through 1997. The arrow marks the average 50% date.

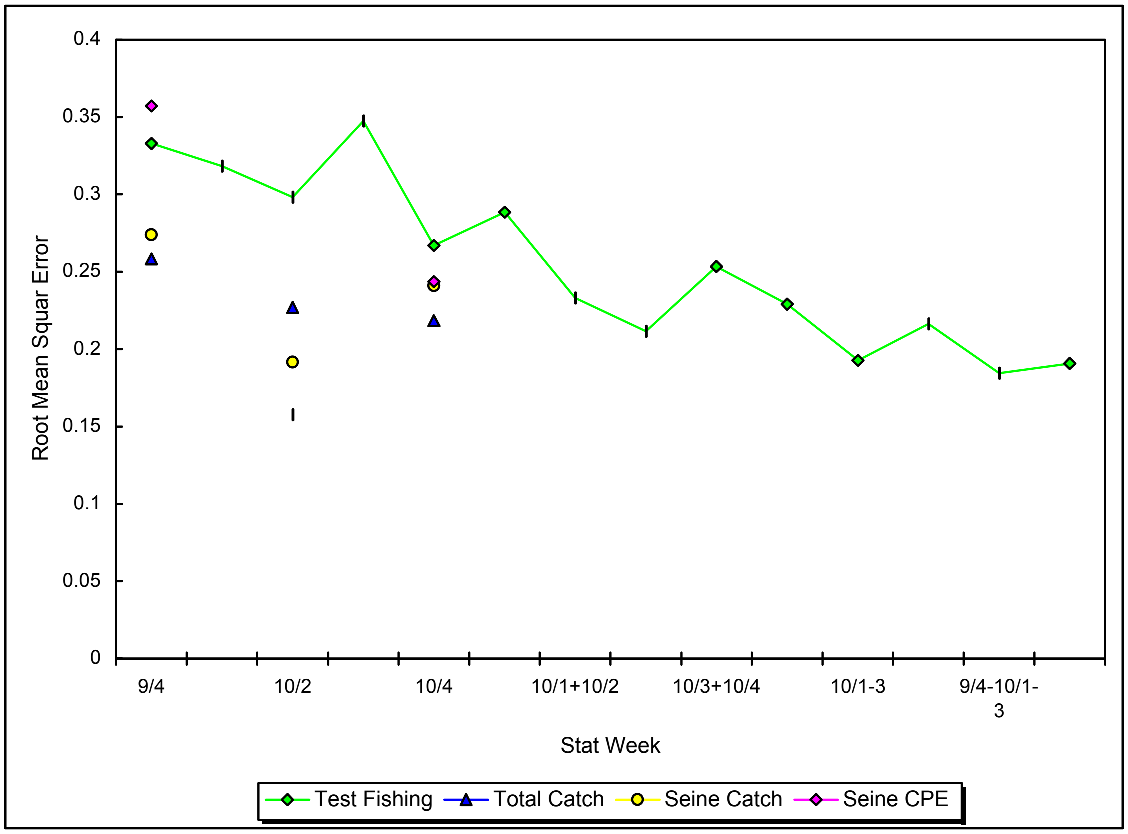



Figure 7.2 Residual mean square error associated with four models used to predict run size estimates in-season.

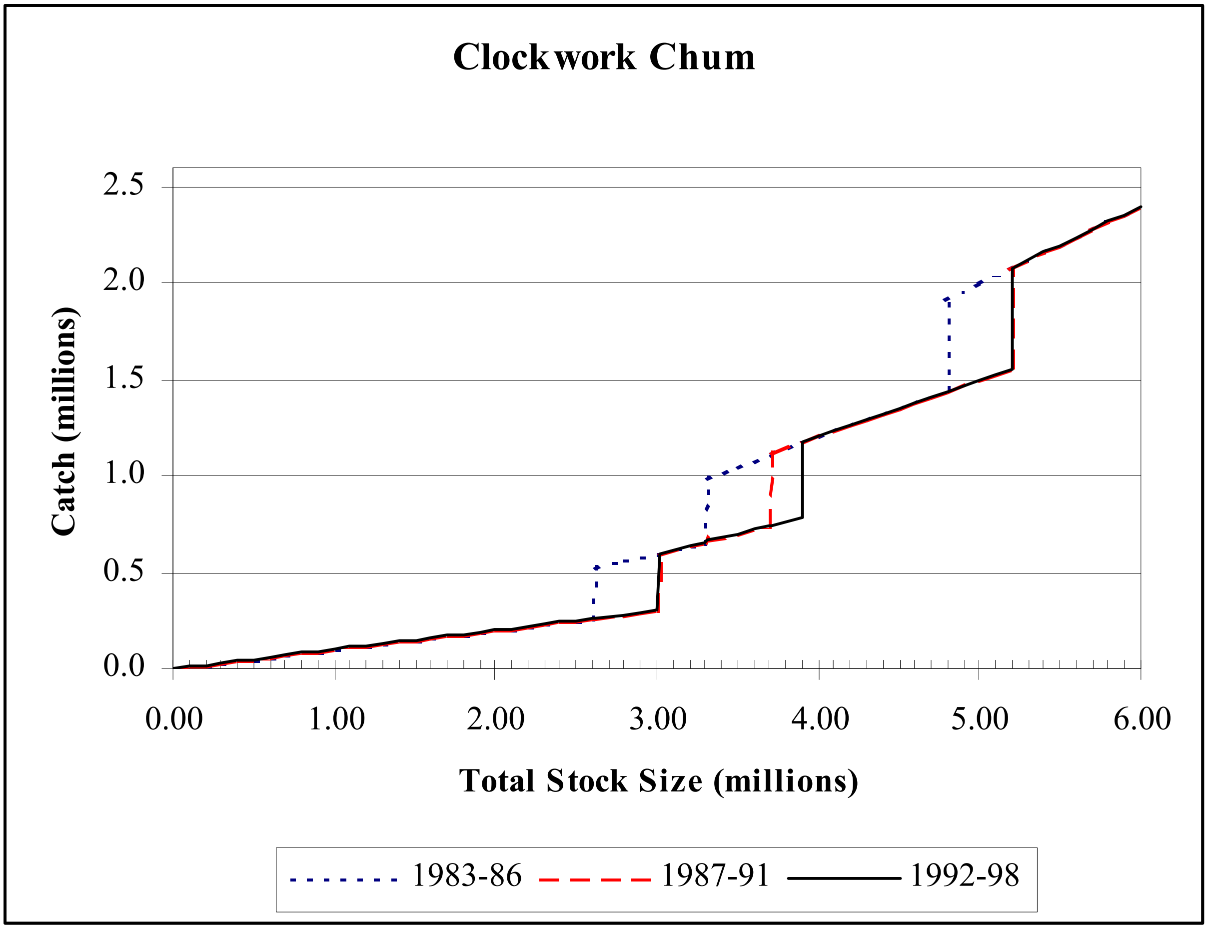



Fig. 8.1 Stepped harvest strategy in place for Clockwork chum.

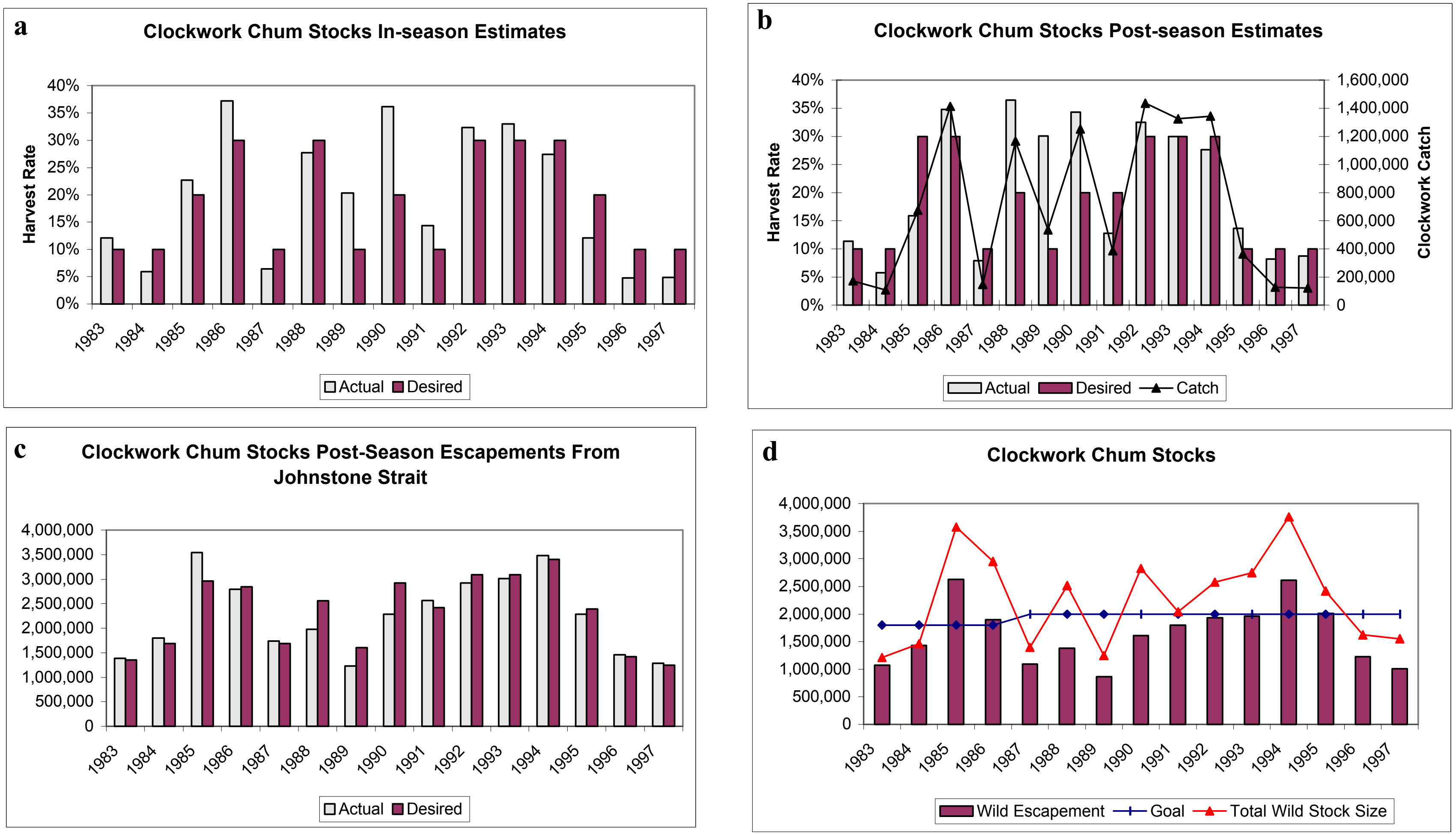



Fig. 8.2 Comparisons between actual and desired levels of harvest rate and escapement according to Clockwork management rules for the years 1983-97.

Figure 8.3. Data from 1968 to 1996

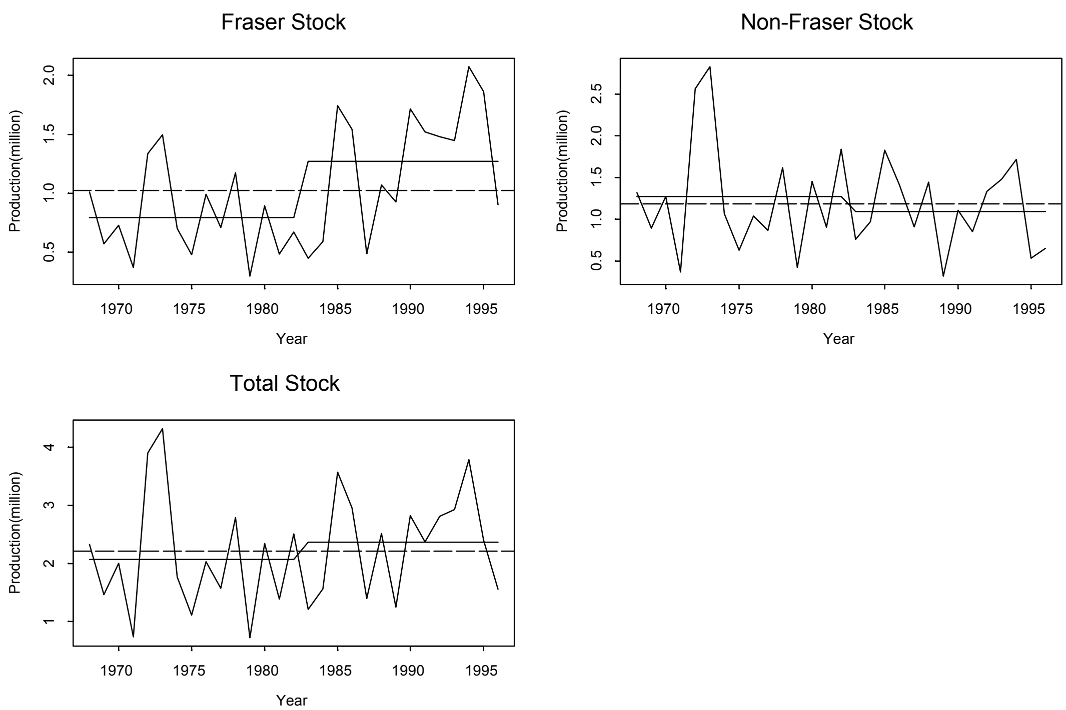



Figure 8.4. Data from 1974 to 1996

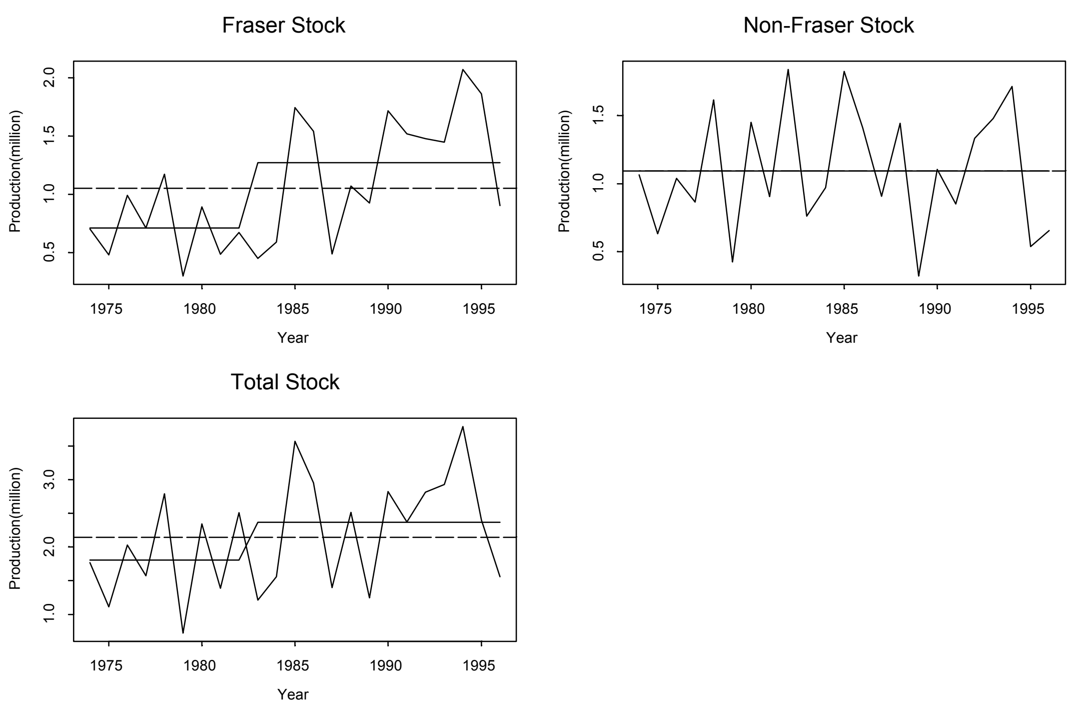


Table 3.1 Number of fed and unfed chum salmon fry released from SEP Operations major facilities (1978-1997 brood years)

| | NUMBER FRY RELEASED BY BROOD YEAR (MILLIONS) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HATCHERY | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| | **FED FRY RELEASES** | | | | | | | | | | | | | | | |
| **NON-FRASER** | | | | | | | | | | | | | | | | |
| PUNTLEDGE | | 1.5 | 3.3 | 2.4 | 7.4 | 6.5 | 7.4 | 5.1 | 4.9 | 4.1 | 3.2 | 2.8 | 5.2 | 5.2 | 4.9 | 3.8 |
| BIG QUALICUM | | | 2.6 | 2.2 | 2.6 | | | | | | | | | | | |
| LITTLE QUALICUM | | | 1.5 | 2.7 | 2.7 | 2.6 | 3.1 | 2.7 | 3.9 | | | | | | | |
| NON-FRASER TOTAL | | 1.5 | 7.4 | 7.3 | 12.7 | 9.1 | 10.5 | 7.7 | 8.8 | 4.1 | 3.2 | 2.8 | 5.2 | 5.2 | 4.9 | 3.8 |
| **FRASER** | | | | | | | | | | | | | | | | |
| CHILLIWACK | | | 0.8 | 3.9 | 4.2 | 1.2 | 3.4 | 4.1 | 4.5 | 2.8 | 2.6 | 3.1 | 3.0 | 3.0 | 3.0 | 2.5 |
| INCH | 0.9 | 1.1 | 0.9 | 1.3 | 2.5 | 2.3 | 2.3 | 1.8 | 1.1 | 1.0 | 1.1 | 1.2 | 0.7 | 0.9 | 1.0 | 1.1 |
| STAVE | | | | | 2.2 | 3.4 | 4.0 | 5.3 | 5.5 | 3.9 | 5.1 | 4.9 | 4.4 | 4.7 | 4.1 | 4.9 |
| BLANEY | 0.2 | 0.3 | 0.2 | 1.8 | 0.6 | 0.6 | 1.0 | 1.0 | 0.9 | | | | | | | |
| CHEHALIS | | | | | 8.3 | 13.6 | 14.0 | 17.0 | 13.5 | 12.3 | 14.2 | 11.0 | 12.8 | 12.4 | 10.4 | 10.9 |
| FRASER TOTAL | 1.1 | 1.4 | 2.0 | 7.0 | 17.7 | 21.1 | 24.8 | 29.2 | 25.4 | 19.9 | 23.0 | 20.2 | 20.9 | 20.9 | 18.5 | 19.5 |
| FED TOTAL | 1.1 | 2.8 | 9.4 | 14.3 | 30.4 | 30.2 | 35.3 | 36.9 | 34.2 | 24.0 | 26.2 | 23.1 | 26.1 | 26.1 | 23.4 | 23.2 |
| % Change from previous year | | 152.4% | 234.4% | 51.5% | 112.4% | -0.7% | 16.8% | 4.7% | -7.4% | -29.8% | 9.3% | -12.0% | 13.2% | 0.1% | -10.4% | -0.7% |
| | **UNFED FRY RELEASES** | | | | | | | | | | | | | | | |
| **NON-FRASER** | | | | | | | | | | | | | | | | |
| PUNTLEDGE | | | | | | | | 0.4 | | | | | | | | |
| BIG QUALICUM | 45.5 | 57.8 | 60.7 | 43.7 | 58.9 | 58.2 | 24.0 | 26.0 | 48.1 | 56.6 | 66.0 | 47.1 | 45.5 | 35.6 | 66.8 | 63.5 |
| LITTLE QUALICUM | | 6.1 | 6.1 | 1.4 | 22.8 | 18.9 | 21.2 | 6.9 | 40.1 | 39.4 | 37.5 | 28.0 | 42.7 | 32.1 | 42.5 | 30.6 |
| NON-FRASER TOTAL | 45.5 | 63.9 | 66.9 | 45.1 | 81.8 | 77.1 | 45.2 | 33.3 | 88.2 | 96.0 | 103.5 | 75.1 | 88.2 | 67.7 | 109.3 | 94.1 |
| **FRASER** | | | | | | | | | | | | | | | | |
| INCH | | | | | | | | | | | | | 0.1 | 0.1 | | |
| CHILLIWACK | | | | | | | | | | | | 1.9 | 2.4 | 2.4 | 0.9 | 1.3 |
| FRASER TOTAL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 2.5 | 2.5 | 0.9 | 1.3 |
| UNFED TOTAL | 45.5 | 63.9 | 66.9 | 45.1 | 81.8 | 77.1 | 45.2 | 33.3 | 88.2 | 96.0 | 103.5 | 77.0 | 90.7 | 70.1 | 110.2 | 95.4 |
| % Change | | 40.4% | 4.7% | -32.6% | 81.4% | -5.7% | -41.4% | -26.4% | 165.1% | 8.8% | 7.8% | -25.6% | 17.8% | -22.6% | 57.2% | -13.5% |

Table 3.1 (con't). Number of fed and unfed chum salmon fry released from SEP Operations major facilities (1978-1997 brood years

| | NUMBER FRY RELEASED BY BROOD YEAR (MILLIONS) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HATCHERY | 1994 | 1995 | 1996 | 1997 | ORIGINAL TARGET | CURRENT TARGET | MEAN 78-81 | MEAN 82-86 | MEAN 87-97 |
| | **FED FRY RELEASES** | | | | | | | | |
| **NON-FRASER** | | | | | | | | | |
| PUNTLEDGE | 5.0 | 4.4 | 3.9 | 5.8 | 5.0 | 3.8 | 1.8 | 6.3 | 4.4 |
| BIG QUALICUM | | | 1.6 | 1.3 | | | 1.2 | 0.5 | 0.3 |
| LITTLE QUALICUM | | | 2.1 | | | | 1.1 | 3.0 | 0.2 |
| NON-FRASER TOTAL | 5.0 | 4.4 | 7.5 | 7.1 | 5.0 | 3.8 | 4.0 | 9.7 | 4.8 |
| **FRASER** | | | | | | | | | |
| CHILLIWACK | 3.1 | 3.1 | 2.5 | 2.9 | 3.5 | 3.0 | 1.2 | 3.5 | 2.9 |
| INCH | 1.1 | 1.2 | 1.1 | 1.2 | 1.5 | 1.0 | 1.1 | 2.0 | 1.1 |
| STAVE | 4.8 | 4.6 | 3.1 | 2.1 | 4.6 | 0.0 | 0.0 | 4.1 | 4.2 |
| BLANEY | | | | | 0.6 | - | 0.6 | 0.8 | 0.0 |
| CHEHALIS | 8.9 | 11.0 | 9.2 | 8.8 | 13.6 | 7.8 | 0.0 | 13.3 | 11.1 |
| FRASER TOTAL | 17.9 | 19.8 | 15.9 | 15.0 | 23.8 | 11.8 | 2.9 | 23.6 | 19.2 |
| FED TOTAL | 22.9 | 24.2 | 23.4 | 22.0 | 28.8 | 15.6 | 6.9 | 33.4 | 24.1 |
| % Change | -1.4% | 5.8% | -3.4% | -5.9% | | -46.0% | | 382.1% | -27.9% |
| | **UNFED FRY RELEASES** | | | | | | | | |
| **NON-FRASER** | | | | | | | | | |
| PUNTLEDGE | | 0.2 | | | | | 0.0 | 0.1 | 0.0 |
| BIG QUALICUM | 46.0 | 17.1 | 6.7 | 30.2 | 53.6 | 45.0 | 51.9 | 43.0 | 43.7 |
| LITTLE QUALICUM | 31.9 | 11.0 | 6.8 | 9.4 | 34.6 | 38.0 | 3.4 | 22.0 | 28.4 |
| NON-FRASER TOTAL | 78.0 | 28.4 | 13.6 | 39.6 | 88.2 | 83.0 | 55.3 | 65.1 | 72.1 |
| **FRASER** | | | | | | | | | |
| INCH | 0.0 | | | | | | 0.0 | 0.0 | 0.0 |
| CHILLIWACK | 1.7 | 1.7 | | 0.5 | 0.4 | 1.9 | 0.0 | 0.0 | 1.2 |
| FRASER TOTAL | 1.7 | 1.7 | 0.0 | 0.5 | 0.4 | 1.9 | 0.0 | 0.0 | 1.2 |
| UNFED TOTAL | 79.7 | 30.1 | 13.6 | 40.1 | 88.6 | 84.9 | 55.3 | 65.1 | 73.3 |
| % Change | -16.5% | -62.3% | -54.8% | 195.1% | | -4.2% | | 17.7% | 12.6% |

Table 3.2.1 ISC enhanced facilities contribution to commercial net catch (does not include non-sampled strata including U.S., troll, sport, or native catches)

| Rtn Yr | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | | 98,783 | | | | 687 | 2,069 | | 101,539 | 98,783 | 2,756 |
| 1981 | | 46,206 | | | | 274 | 33 | | 46,513 | 46,206 | 307 |
| 1982 | 4,750 | 207,514 | 2,823 | | | 669 | 1,556 | | 217,312 | 215,087 | 2,225 |
| 1983 | 7,259 | 100,422 | 3,905 | 0 | | 61 | 0 | | 111,647 | 111,586 | 61 |
| 1984 | 16,767 | 149,880 | 10,642 | 1,694 | | 0 | 1,999 | | 180,982 | 177,289 | 3,693 |
| 1985 | 56,261 | 408,946 | 120,036 | 12,434 | 9,598 | 1,139 | 2,209 | 2,396 | 613,019 | 585,243 | 27,776 |
| 1986 | 87,540 | 333,338 | 164,032 | 49,785 | 55,922 | 2,863 | 2,112 | 14,321 | 709,913 | 584,910 | 125,003 |
| 1987 | 73,540 | 142,512 | 59,859 | 2,504 | 2,949 | 132 | 1,702 | 614 | 283,812 | 275,911 | 7,901 |
| 1988 | 17,232 | 119,042 | 59,821 | 54,791 | 81,472 | 12,275 | 8,349 | 51,371 | 404,353 | 196,095 | 208,258 |
| 1989 | 11,004 | 91,454 | 41,327 | 10,606 | 57,235 | 1,570 | 2,585 | 18,571 | 234,352 | 143,785 | 90,567 |
| 1990 | 33,013 | 200,952 | 77,058 | 26,543 | 64,536 | 1,848 | 3,718 | 48,431 | 456,099 | 311,023 | 145,076 |
| 1991 | 60,578 | 178,972 | 36,025 | 9,201 | 17,217 | 0 | 1,653 | 7,658 | 311,304 | 275,575 | 35,729 |
| 1992 | 27,367 | 837,952 | 183,129 | 32,600 | 50,878 | 0 | 4,741 | 40,044 | 1,176,711 | 1,048,448 | 128,263 |
| 1993 | 57,477 | 557,149 | 141,664 | 38,422 | 48,772 | | 6,700 | 41,750 | 891,934 | 756,290 | 135,644 |
| 1994 | 39,263 | 356,921 | 154,484 | 31,601 | 53,446 | | 4,027 | 29,981 | 669,723 | 550,668 | 119,055 |
| 1995 | 4,588 | 24,887 | 6,896 | 7,072 | 16,528 | | 2,339 | 7,562 | 69,873 | 36,371 | 33,502 |
| 1996 | 0 | 1,662 | 505 | 2,290 | 0 | | 0 | 213 | 4,670 | 2,168 | 2,503 |
| 1997* | 816 | 2,939 | 893 | 3,501 | 638 | | 0 | 945 | 9,732 | 4,648 | 5,084 |
| *Data for 1997 is preliminary. | | | | | | | | | | | |
| Total | | | | | | | | | | | |
| 80-84 | 28,776 | 602,805 | 17,370 | 1,694 | | 1,691 | 5,657 | | 657,993 | 648,951 | 9,042 |
| 85-89 | 245,577 | 1,095,292 | 445,075 | 130,120 | 207,176 | 17,979 | 16,957 | 87,273 | 2,245,449 | 1,785,944 | 459,505 |
| 90-94 | 217,698 | 2,131,946 | 592,360 | 138,367 | 234,849 | 1,848 | 20,839 | 167,864 | 3,505,771 | 2,942,004 | 563,767 |
| 95-97 | 5,404 | 29,488 | 8,294 | 12,863 | 17,166 | | 2,339 | 8,720 | 84,275 | 43,187 | 41,088 |
| 85-94 | 463,275 | 3,227,238 | 1,037,435 | 268,487 | 442,025 | 19,827 | 37,796 | 255,137 | 5,751,220 | 4,727,948 | 1,023,272 |
| 85-97 | 468,679 | 3,256,726 | 1,045,729 | 281,350 | 459,191 | 19,827 | 40,135 | 263,857 | 5,835,495 | 4,771,135 | 1,064,360 |
| All | 497,455 | 3,859,531 | 1,063,099 | 283,044 | 459,191 | 21,518 | 45,792 | 263,857 | 6,493,488 | 5,420,086 | 1,073,402 |
| Annual Mean | | | | | | | | | | | |
| 80-84 | 9,592 | 120,561 | 5,790 | 847 | | 338 | 1,131 | | 131,599 | 129,790 | 1,808 |
| 85-89 | 49,115 | 219,058 | 89,015 | 26,024 | 41,435 | 3,596 | 3,391 | 17,455 | 449,090 | 357,189 | 91,901 |
| 90-94 | 43,540 | 426,389 | 118,472 | 27,673 | 46,970 | 616 | 4,168 | 33,573 | 701,154 | 588,401 | 112,753 |
| 95-97 | 1,801 | 9,829 | 2,765 | 4,288 | 5,722 | | 780 | 2,907 | 28,092 | 14,396 | 13,696 |
| 85-94 | 46,328 | 322,724 | 103,744 | 26,849 | 44,203 | 2,478 | 3,780 | 25,514 | 575,122 | 472,795 | 102,327 |
| 85-97 | 36,052 | 250,517 | 80,441 | 21,642 | 35,322 | 2,478 | 3,087 | 20,297 | 448,884 | 367,010 | 81,874 |
| All | 31,091 | 214,418 | 66,444 | 18,870 | 35,322 | 1,655 | 2,544 | 20,297 | 360,749 | 301,116 | 59,633 |

Table 3.2.2 Inner South Coast enhanced facilities contribution to escapement.

| Rtn Yr | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | | 97,575 | | | | 622 | 1,870 | | 100,067 | 97,575 | 2,492 |
| 1981 | | 88,831 | | | | 3,482 | 1,702 | | 94,015 | 88,831 | 5,184 |
| 1982 | 3,189 | 139,344 | 12,272 | | | 696 | 6,158 | | 161,659 | 154,805 | 6,854 |
| 1983 | 10,566 | 145,648 | 24,121 | 174 | | 448 | 5,262 | | 186,219 | 180,335 | 5,884 |
| 1984 | 17,706 | 100,220 | 25,558 | 4,322 | | 2,992 | 2,374 | | 153,172 | 143,484 | 9,688 |
| 1985 | 24,529 | 188,583 | 60,907 | 44,076 | 42,456 | 9,936 | 14,459 | 46,099 | 431,045 | 274,019 | 157,026 |
| 1986 | 43,019 | 167,302 | 78,940 | 35,635 | 119,115 | 5,593 | 10,288 | 48,809 | 508,701 | 289,261 | 219,440 |
| 1987 | 37,431 | 76,422 | 28,901 | 23,848 | 37,324 | 179 | 15,783 | 4,840 | 224,728 | 142,754 | 81,974 |
| 1988 | 10,488 | 86,615 | 39,411 | 22,201 | 73,913 | 3,575 | 9,161 | 55,402 | 300,766 | 136,514 | 164,252 |
| 1989 | 9,541 | 61,243 | 34,741 | 21,033 | 128,244 | 4,676 | 1,403 | 70,093 | 330,974 | 105,525 | 225,449 |
| 1990 | 32,455 | 66,464 | 52,810 | 13,989 | 128,576 | 1,429 | 2,616 | 63,678 | 362,017 | 151,729 | 210,288 |
| 1991 | 6,322 | 83,320 | 67,248 | 28,971 | 101,113 | 0 | 5,601 | 51,193 | 343,768 | 156,890 | 186,878 |
| 1992 | 22,475 | 123,478 | 55,435 | 27,633 | 64,389 | | 11,116 | 78,830 | 383,356 | 201,388 | 181,968 |
| 1993 | 8,488 | 204,888 | 104,030 | 98,428 | 45,207 | | 7,225 | 120,819 | 589,085 | 317,406 | 271,679 |
| 1994 | 30,347 | 146,693 | 134,316 | 70,445 | 48,951 | | 14,644 | 39,711 | 485,107 | 311,356 | 173,751 |
| 1995 | 17,797 | 57,531 | 29,707 | 31,222 | 42,268 | | 6,341 | 21,193 | 206,058 | 105,035 | 101,023 |
| 1996 | 6,785 | 45,696 | 15,985 | 28,712 | 52,829 | | 5,533 | 47,819 | 203,358 | 68,466 | 134,892 |
| 1997* | 24,064 | 86,673 | 31,552 | 34,721 | 78,741 | | 38,313 | 16,244 | 310,309 | 142,289 | 168,020 |

*Data for 1997 is preliminary. Puntledge 1997 escapement is estimated from Big Qualicum exploitation rate.

| Total | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-84 | 31,461 | 571,618 | 61,951 | 4,496 | | 8,240 | 17,366 | | 695,132 | 665,030 | 30,102 |
| 85-89 | 125,008 | 580,165 | 242,900 | 146,793 | 401,052 | 23,959 | 51,094 | 225,243 | 1,796,214 | 948,073 | 848,141 |
| 90-94 | 100,087 | 624,843 | 413,839 | 239,466 | 388,236 | 1,429 | 41,202 | 354,231 | 2,163,333 | 1,138,769 | 1,024,564 |
| 95-97 | 48,646 | 189,900 | 77,244 | 94,655 | 173,838 | | 50,187 | 85,256 | 719,726 | 315,790 | 403,935 |
| 85-94 | 225,095 | 1,205,008 | 656,739 | 386,259 | 789,288 | 25,388 | 92,296 | 579,474 | 3,959,547 | 2,086,842 | 1,872,705 |
| 85-97 | 273,741 | 1,394,908 | 733,983 | 480,914 | 963,126 | 25,388 | 142,483 | 664,730 | 4,679,273 | 2,402,632 | 2,276,640 |
| All | 305,202 | 1,966,526 | 795,934 | 485,410 | 963,126 | 33,628 | 159,849 | 664,730 | 5,374,405 | 3,067,662 | 2,306,742 |

| Annual Mean | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-84 | 10,487 | 114,324 | 20,650 | 2,248 | | 1,648 | 3,473 | | 139,026 | 133,006 | 6,020 |
| 85-89 | 25,002 | 116,033 | 48,580 | 29,359 | 80,210 | 4,792 | 10,219 | 45,049 | 359,243 | 189,615 | 169,628 |
| 90-94 | 20,017 | 124,969 | 82,768 | 47,893 | 77,647 | 715 | 8,240 | 70,846 | 432,667 | 227,754 | 204,913 |
| 95-97 | 16,215 | 63,300 | 25,748 | 31,552 | 57,946 | | 16,729 | 28,419 | 239,909 | 105,263 | 134,645 |
| 85-94 | 22,510 | 120,501 | 65,674 | 38,626 | 78,929 | 3,627 | 9,230 | 57,947 | 395,955 | 208,684 | 187,271 |
| 85-97 | 21,057 | 107,301 | 56,460 | 36,993 | 74,087 | 3,627 | 10,960 | 51,133 | 359,944 | 184,818 | 175,126 |
| All | 19,075 | 109,251 | 49,746 | 32,361 | 74,087 | 2,802 | 8,880 | 51,133 | 298,578 | 170,426 | 128,152 |

Table 3.2.3 Inner South Coast enhanced facilities contribution to commercial net catch + escapement (does not include non-sampled strata including U.S., troll, sport, or native catches)

| Rtn Yr | Puntledge | Big Qualicum | L Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | | 196,358 | | | | 1,309 | 3,939 | | 201,606 | 196,358 | 5,248 |
| 1981 | | 135,037 | | | | 3,756 | 1,735 | | 140,528 | 135,037 | 5,491 |
| 1982 | 7,939 | 346,858 | 15,095 | 0 | | 1,365 | 7,714 | | 378,971 | 369,892 | 9,079 |
| 1983 | 17,825 | 246,070 | 28,026 | 174 | | 509 | 5,262 | | 297,866 | 291,921 | 5,945 |
| 1984 | 34,473 | 250,100 | 36,200 | 6,016 | | 2,992 | 4,373 | | 334,154 | 320,773 | 13,381 |
| 1985 | 80,790 | 597,529 | 180,943 | 56,510 | 52,054 | 11,075 | 16,668 | 48,495 | 1,044,064 | 859,262 | 184,802 |
| 1986 | 130,559 | 500,640 | 242,972 | 85,420 | 175,037 | 8,456 | 12,400 | 63,130 | 1,218,614 | 874,171 | 344,443 |
| 1987 | 110,971 | 218,934 | 88,760 | 26,352 | 40,273 | 311 | 17,485 | 5,454 | 508,540 | 418,665 | 89,875 |
| 1988 | 27,720 | 205,657 | 99,232 | 76,992 | 155,385 | 15,850 | 17,510 | 106,773 | 705,119 | 332,609 | 372,510 |
| 1989 | 20,545 | 152,697 | 76,068 | 31,639 | 185,479 | 6,246 | 3,988 | 88,664 | 565,326 | 249,310 | 316,016 |
| 1990 | 65,468 | 267,416 | 129,868 | 40,532 | 193,112 | 3,277 | 6,334 | 112,109 | 818,116 | 462,752 | 355,364 |
| 1991 | 66,900 | 262,292 | 103,273 | 38,172 | 118,330 | 0 | 7,254 | 58,851 | 655,072 | 432,465 | 222,607 |
| 1992 | 49,842 | 961,430 | 238,564 | 60,233 | 115,267 | | 15,857 | 118,874 | 1,560,067 | 1,249,836 | 310,231 |
| 1993 | 65,965 | 762,037 | 245,694 | 136,850 | 93,979 | | 13,925 | 162,569 | 1,481,019 | 1,073,696 | 407,323 |
| 1994 | 69,610 | 503,614 | 288,800 | 102,046 | 102,397 | | 18,671 | 69,692 | 1,154,830 | 862,024 | 292,806 |
| 1995 | 22,385 | 82,418 | 36,603 | 38,294 | 58,796 | | 8,680 | 28,755 | 275,930 | 141,406 | 134,524 |
| 1996 | 6,785 | 47,359 | 16,490 | 31,001 | 52,829 | | 5,533 | 48,032 | 208,029 | 70,634 | 137,395 |
| 1997* | 24,880 | 89,612 | 32,445 | 38,222 | 79,379 | | 38,313 | 17,189 | 320,041 | 146,937 | 173,104 |

*Data for 1997 is preliminary. Puntledge 1997 escapement is estimated from Big Qualicum exploitation rate.

| Total | Puntledge | Big Qualicum | L Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-84 | 60,237 | 1,174,423 | 79,321 | 6,190 | | 9,931 | 23,023 | | 1,353,125 | 1,313,981 | 39,144 |
| 85-89 | 370,585 | 1,675,457 | 687,975 | 276,913 | 608,228 | 41,938 | 68,051 | 312,516 | 4,041,663 | 2,734,017 | 1,307,646 |
| 90-94 | 317,785 | 2,756,789 | 1,006,199 | 377,833 | 623,085 | 3,277 | 62,041 | 522,095 | 5,669,104 | 4,080,773 | 1,588,331 |
| 95-97 | 54,050 | 219,389 | 85,538 | 107,518 | 191,004 | | 52,526 | 93,976 | 804,000 | 358,977 | 445,023 |
| 85-94 | 688,370 | 4,432,246 | 1,694,174 | 654,746 | 1,231,313 | 45,215 | 130,092 | 834,611 | 9,710,767 | 6,814,790 | 2,895,977 |
| 85-97 | 742,420 | 4,651,635 | 1,779,712 | 762,264 | 1,422,317 | 45,215 | 182,618 | 928,587 | 10,514,767 | 7,173,767 | 3,341,000 |
| All | 802,657 | 5,826,058 | 1,859,033 | 768,454 | 1,422,317 | 55,146 | 205,641 | 928,587 | 11,867,892 | 8,487,748 | 3,380,144 |

| Annual Mean | Puntledge | Big Qualicum | L Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-84 | 20,079 | 234,885 | 26,440 | 2,063 | | 1,986 | 4,605 | | 270,625 | 262,796 | 7,829 |
| 85-89 | 74,117 | 335,091 | 137,595 | 55,383 | 121,646 | 8,388 | 13,610 | 62,503 | 808,333 | 546,803 | 261,529 |
| 90-94 | 63,557 | 551,358 | 201,240 | 75,567 | 124,617 | 1,639 | 12,408 | 104,419 | 1,133,821 | 816,155 | 317,666 |
| 95-97 | 18,017 | 73,130 | 28,513 | 35,839 | 63,668 | | 17,509 | 31,325 | 268,000 | 119,659 | 148,341 |
| 85-94 | 68,837 | 443,225 | 169,417 | 65,475 | 123,131 | 6,459 | 13,009 | 83,461 | 971,077 | 681,479 | 289,598 |
| 85-97 | 57,109 | 357,818 | 136,901 | 58,636 | 109,409 | 6,459 | 14,048 | 71,430 | 808,828 | 551,828 | 257,000 |
| All | 50,166 | 323,670 | 116,190 | 48,028 | 109,409 | 4,596 | 11,425 | 71,430 | 659,327 | 471,542 | 187,786 |

Table 3.2.4 Inner South Coast enhanced chum contribution as a percent of enhanced + wild chum catch and escapement (does not include non-sampled strata including U.S., troll, sport, or native catches)

| | Inside | | | Fraser | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| Rtn.Yr. | Catch | Esc | Total | Catch | Esc | Total | Catch | Esc | Total |
| 1962 | 3.6 | 7.5 | 6.4 | | | | 2.7 | 6.0 | 5.1 |
| 1963 | 13.2 | 7.9 | 9.6 | | | | 9.3 | 5.6 | 6.8 |
| 1964 | 5.3 | 6.4 | 6.3 | | | | 3.3 | 4.5 | 4.3 |
| 1965 | 1.0 | 8.7 | 7.8 | | | | 1.1 | 5.5 | 5.2 |
| 1966 | 0.3 | 9.4 | 8.7 | | | | 0.4 | 5.8 | 5.5 |
| 1967 | 6.5 | 8.6 | 8.2 | | | | 5.5 | 6.0 | 5.9 |
| 1968 | 7.3 | 13.1 | 11.5 | | | | 4.8 | 8.1 | 7.2 |
| 1969 | 27.1 | 14.3 | 18.9 | | | | 18.0 | 10.0 | 12.9 |
| 1970 | 14.8 | 15.1 | 15.0 | | | | 9.5 | 11.4 | 10.5 |
| 1971 | 5.8 | 27.3 | 23.2 | | | | 4.7 | 15.6 | 14.1 |
| 1972 | 11.8 | 5.4 | 8.6 | | | | 8.6 | 4.2 | 6.4 |
| 1973 | 14.8 | 12.2 | 13.7 | | | | 10.2 | 10.2 | 10.2 |
| 1974 | 3.0 | 10.4 | 8.6 | | | | 2.3 | 7.5 | 6.3 |
| 1975 | 15.5 | 22.8 | 20.0 | | | | 10.3 | 16.3 | 13.9 |
| 1976 | 15.2 | 15.8 | 15.5 | | | | 9.9 | 10.3 | 10.1 |
| 1977 | 5.9 | 12.1 | 11.3 | | | | 5.3 | 7.1 | 7.0 |
| 1978 | 29.5 | 11.5 | 19.9 | | | | 20.0 | 8.7 | 14.2 |
| 1979 | 10.3 | 26.7 | 25.0 | | | | 10.1 | 17.7 | 17.2 |
| 1980 | 16.6 | 9.2 | 11.9 | 1.1 | 0.8 | 0.9 | 12.3 | 7.3 | 9.2 |
| 1981 | 33.4 | 9.8 | 12.9 | 0.9 | 1.2 | 1.2 | 38.6 | 7.0 | 9.6 |
| 1982 | 19.1 | 14.2 | 16.7 | 0.9 | 2.1 | 1.6 | 15.7 | 11.5 | 13.6 |
| 1983 | 50.8 | 21.5 | 27.6 | 0.1 | 1.6 | 1.4 | 48.0 | 15.5 | 20.7 |
| 1984 | 71.9 | 13.6 | 24.6 | 7.7 | 1.8 | 2.3 | 88.6 | 9.6 | 18.5 |
| 1985 | 45.4 | 17.3 | 29.9 | 10.2 | 12.1 | 11.8 | 56.1 | 15.0 | 26.3 |
| 1986 | 39.3 | 25.4 | 33.3 | 31.2 | 22.6 | 25.1 | 44.4 | 24.1 | 32.8 |
| 1987 | 50.0 | 16.6 | 29.6 | 13.7 | 20.6 | 19.7 | 63.7 | 17.8 | 29.9 |
| 1988 | 17.1 | 13.8 | 15.6 | 69.9 | 28.1 | 42.3 | 31.9 | 19.1 | 24.8 |
| 1989 | 29.6 | 26.7 | 28.3 | 35.7 | 38.5 | 37.6 | 40.5 | 33.8 | 36.3 |
| 1990 | 26.9 | 20.1 | 24.2 | 31.2 | 21.3 | 24.5 | 31.3 | 20.7 | 25.6 |
| 1991 | 38.1 | 20.5 | 29.3 | 26.0 | 15.7 | 16.9 | 43.9 | 17.6 | 24.9 |
| 1992 | 60.3 | 17.5 | 43.4 | 36.3 | 18.6 | 23.4 | 61.0 | 18.0 | 38.6 |
| 1993 | 43.0 | 26.5 | 36.4 | 50.7 | 27.4 | 32.5 | 47.8 | 26.9 | 36.6 |
| 1994 | 34.7 | 24.2 | 30.0 | 33.9 | 11.4 | 15.7 | 38.1 | 17.3 | 25.3 |
| 1995 | 10.0 | 26.9 | 17.9 | 36.0 | 6.0 | 7.8 | 22.5 | 10.0 | 11.9 |
| 1996 | 0.7 | 15.4 | 9.5 | 15.6 | 15.5 | 15.6 | 4.6 | 12.6 | 12.1 |
| 1997 | 1.3 | 29.3 | 17.4 | 14.0 | 25.6 | 25.0 | 4.8 | 15.2 | 14.3 |
| | | | | | | | | | |
| Annual Mean | | | | | | | | | |
| 80-84 | 38.4 | 13.6 | 18.7 | 2.1 | 1.5 | 1.5 | 40.7 | 10.2 | 14.3 |
| 85-89 | 36.3 | 19.9 | 27.4 | 32.1 | 24.4 | 27.3 | 47.3 | 21.9 | 30.0 |
| 90-94 | 40.6 | 21.7 | 32.7 | 35.6 | 18.9 | 22.6 | 44.4 | 20.1 | 30.2 |
| 95-97 | 4.0 | 23.9 | 15.0 | 21.9 | 15.7 | 16.1 | 10.7 | 12.6 | 12.8 |
| 85-94 | 38.4 | 20.8 | 30.0 | 33.9 | 21.6 | 24.9 | 45.9 | 21.0 | 30.1 |
| 85-97 | 30.5 | 21.5 | 26.5 | 31.1 | 20.3 | 22.9 | 37.7 | 19.1 | 26.1 |
| 80-97 | 32.7 | 19.3 | 24.4 | 23.1 | 15.0 | 16.9 | 38.5 | 16.6 | 22.8 |

Table 3.2.5 Inner South Coast enhanced facilities contribution to natural escapement 1992-1997.

| Rtn Yr | Puntledge | L.Qualicum | Chilliwack | Chehalis | Inch | Stave | Total | Inside | Fraser |
|---|---|---|---|---|---|---|---|---|---|
| 1992 | 17,731 | 6,663 | 20,048 | 15,538 | 829 | 75,702 | 136,511 | 24,394 | 112,117 |
| 1993 | 5,888 | 51,397 | 67,220 | 11,466 | 2,050 | 113,662 | 251,683 | 57,285 | 194,398 |
| 1994 | 18,217 | 69,745 | 45,318 | 20,542 | 2,494 | 6,656 | 162,972 | 87,962 | 75,010 |
| 1995 | 10,500 | 4,666 | 22,332 | 517 | 1,996 | 19,895 | 59,906 | 15,166 | 44,740 |
| 1996 | 2,544 | 9,929 | 21,890 | 3,448 | 634 | 45,340 | 83,785 | 12,473 | 71,312 |
| 1997* | | 12,016 | 9,083 | 25,563 | 2,129 | 36,759 | 85,549 | 12,016 | 73,533 |
| Mean | 10,976 | 25,736 | 30,982 | 12,846 | 1,689 | 49,669 | 131,897 | 36,712 | 95,185 |

*Puntledge 1997 escapement is unavailable

Table 3.3.1 Inner South Coast enhanced facilities commercial net exploitation rate (does not include non-sampled strata including U.S., troll, sport, or native catches)

| Rtn Yr | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Inside | Fraser | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | | 50.3 | | | | 52.5 | 52.5 | | 50.3 | 52.5 | 50.4 |
| 1981 | | 34.2 | | | | 7.3 | 1.9 | | 34.2 | 5.6 | 33.1 |
| 1982 | 59.8 | 59.8 | 18.7 | | | 49.0 | 20.2 | | 58.1 | 24.5 | 57.3 |
| 1983 | 40.7 | 40.8 | 13.9 | 0.0 | | 12.0 | 0.0 | | 38.2 | 1.0 | 37.5 |
| 1984 | 48.6 | 59.9 | 29.4 | 28.2 | | 0.0 | 45.7 | | 55.3 | 27.6 | 54.2 |
| 1985 | 69.6 | 68.4 | 66.3 | 22.0 | 18.4 | 10.3 | 13.3 | 4.9 | 68.1 | 15.0 | 58.7 |
| 1986 | 67.1 | 66.6 | 67.5 | 58.3 | 31.9 | 33.9 | 17.0 | 22.7 | 66.9 | 36.3 | 58.3 |
| 1987 | 66.3 | 65.1 | 67.4 | 9.5 | 7.3 | 42.4 | 9.7 | 11.3 | 65.9 | 8.8 | 55.8 |
| 1988 | 62.2 | 57.9 | 60.3 | 71.2 | 52.4 | 77.4 | 47.7 | 48.1 | 59.0 | 55.9 | 57.3 |
| 1989 | 53.6 | 59.9 | 54.3 | 33.5 | 30.9 | 25.1 | 64.8 | 20.9 | 57.7 | 28.7 | 41.5 |
| 1990 | 50.4 | 75.1 | 59.3 | 65.5 | 33.4 | 56.4 | 58.7 | 43.2 | 67.2 | 40.8 | 55.7 |
| 1991 | 90.6 | 68.2 | 34.9 | 24.1 | 14.5 | | 22.8 | 13.0 | 63.7 | 16.1 | 47.5 |
| 1992 | 54.9 | 87.2 | 76.8 | 54.1 | 44.1 | | 29.9 | 33.7 | 83.9 | 41.3 | 75.4 |
| 1993 | 87.1 | 73.1 | 57.7 | 28.1 | 51.9 | | 48.1 | 25.7 | 70.4 | 33.3 | 60.2 |
| 1994 | 56.4 | 70.9 | 53.5 | 31.0 | 52.2 | | 21.6 | 43.0 | 63.9 | 40.7 | 58.0 |
| 1995 | 20.5 | 30.2 | 18.8 | 18.5 | 28.1 | | 27.0 | 26.3 | 25.7 | 24.9 | 25.3 |
| 1996 | 0.0 | 3.5 | 3.1 | 7.4 | 0.0 | | 0.0 | 0.4 | 3.1 | 1.8 | 2.2 |
| 1997* | 3.3 | 3.3 | 2.8 | 9.2 | 0.8 | | 0.0 | 5.5 | 3.2 | 2.9 | 3.0 |

*Data for 1997 is preliminary. Puntledge 1997 exploitation rate is estimated from Big Qualicum.

| Total | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Inside | Fraser | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-84 | 47.8 | 51.3 | 21.9 | 27.4 | | 17.0 | 24.6 | | 49.4 | 23.1 | 48.6 |
| 85-89 | 66.3 | 65.4 | 64.7 | 47.0 | 34.1 | 42.9 | 24.9 | 27.9 | 65.3 | 35.1 | 55.6 |
| 90-94 | 68.5 | 77.3 | 58.9 | 36.6 | 37.7 | 56.4 | 33.6 | 32.2 | 72.1 | 35.5 | 61.8 |
| 95-97 | 10.0 | 13.4 | 9.7 | 12.0 | 9.0 | | 4.5 | 9.3 | 12.0 | 9.2 | 10.5 |
| 85-94 | 67.3 | 72.8 | 61.2 | 41.0 | 35.9 | | 29.1 | 30.6 | 69.4 | 35.3 | 59.2 |
| 85-97 | 63.1 | 70.0 | 58.8 | 36.9 | 32.3 | | 22.0 | 28.4 | 66.5 | 31.9 | 55.5 |
| All | 62.0 | 66.2 | 57.2 | 36.8 | 32.3 | 39.0 | 22.3 | 28.4 | 63.9 | 31.8 | 54.7 |

| Annual Mean | Puntledge | Big Qualicum | L.Qualicum | Chilliwack | Chehalis | Blaney | Inch | Stave | Inside | Fraser | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-84 | 49.7 | 49.0 | 20.7 | 14.1 | | 24.2 | 24.1 | | 47.2 | 22.2 | 46.5 |
| 85-89 | 63.7 | 63.6 | 63.2 | 38.9 | 28.2 | 37.8 | 30.5 | 21.6 | 63.5 | 28.9 | 54.3 |
| 90-94 | 67.9 | 74.9 | 56.4 | 40.6 | 39.2 | 56.4 | 36.2 | 31.7 | 69.8 | 34.4 | 59.4 |
| 95-97 | 7.9 | 12.3 | 8.2 | 11.7 | 9.6 | | 9.0 | 10.7 | 10.7 | 9.9 | 10.2 |
| 85-94 | 65.8 | 69.2 | 59.8 | 39.7 | 33.7 | 40.9 | 33.4 | 26.7 | 66.7 | 31.7 | 56.8 |
| 85-97 | 52.5 | 56.1 | 47.9 | 33.2 | 28.2 | 40.9 | 27.7 | 23.0 | 53.7 | 26.7 | 46.1 |
| All | 51.9 | 54.1 | 42.8 | 30.7 | 28.2 | 33.3 | 26.7 | 23.0 | 51.9 | 25.4 | 46.2 |

Table 3.3.2 Inner South Coast enhanced chum % distribution of contribution by area of catch and escapement (does not include strata not sampled-U.S., Troll, Sport, Native).

Non Fraser Enhanced Stocks (Puntledge, Big & Little Qualicum)

| Rtn Yr | Area 2-10 | Area 25-27 | Area 21-24 | Area 11-13 | Area 14-20 | Area 29 | Tot.Marine | Rack* | Brood* | Natural | Tot.Esc |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | 0.0 | 0.0 | 0.0 | 12.7 | 37.6 | 0.0 | 50.3 | | | 49.7 | 49.7 |
| 1981 | 0.0 | 0.0 | 0.0 | 0.0 | 34.2 | 0.0 | 34.2 | | | 65.8 | 65.8 |
| 1982 | 0.0 | 0.0 | 0.0 | 21.0 | 37.1 | 0.0 | 58.1 | | | 41.9 | 41.9 |
| 1983 | 0.0 | 0.0 | 0.0 | 0.0 | 38.2 | 0.0 | 38.2 | | | 61.8 | 61.8 |
| 1984 | 0.0 | 0.0 | 0.0 | 0.0 | 55.3 | 0.0 | 55.3 | | | 44.7 | 44.7 |
| 1985 | 0.0 | 0.0 | 0.0 | 12.7 | 55.4 | 0.0 | 68.1 | | | 31.9 | 31.9 |
| 1986 | 0.0 | 0.0 | 0.0 | 31.4 | 35.5 | 0.0 | 66.9 | | | 33.1 | 33.1 |
| 1987 | 0.0 | 0.0 | 0.0 | 3.3 | 62.6 | 0.0 | 65.9 | | | 34.1 | 34.1 |
| 1988 | 0.0 | 0.0 | 2.5 | 48.2 | 8.3 | 0.0 | 59.0 | | | 41.0 | 41.0 |
| 1989 | 0.0 | 0.0 | 0.9 | 26.7 | 30.1 | 0.0 | 57.7 | | | 42.3 | 42.3 |
| 1990 | 0.0 | 0.0 | 0.0 | 49.8 | 17.4 | 0.0 | 67.2 | | | 32.8 | 32.8 |
| 1991 | 0.0 | 0.0 | 0.0 | 8.6 | 55.1 | 0.0 | 63.7 | | | 36.3 | 36.3 |
| 1992 | 0.0 | 0.0 | 0.2 | 49.4 | 34.2 | 0.1 | 83.9 | 0.6 | 6.8 | 8.7 | 16.1 |
| 1993 | 0.2 | 0.0 | 0.0 | 38.6 | 30.3 | 1.3 | 70.4 | 5.0 | 9.3 | 15.3 | 29.6 |
| 1994 | 0.0 | 0.0 | 0.0 | 31.0 | 32.9 | 0.0 | 63.9 | 2.5 | 23.0 | 10.6 | 36.1 |
| 1995 | 0.0 | 0.0 | 0.2 | 23.1 | 2.4 | 0.0 | 25.7 | 0.0 | 63.6 | 10.7 | 74.3 |
| 1996 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 3.1 | 0.0 | 79.3 | 17.7 | 96.9 |
| 1997 | 0.0 | 0.0 | 0.0 | 3.2 | 0.0 | 0.0 | 3.2 | 0.6 | 30.1 | 66.1 | 96.8 |
| Annual Mean | | | | | | | | | | | |
| 80-84 | 0.0 | 0.0 | 0.0 | 6.7 | 40.5 | 0.0 | 47.2 | | | 52.8 | 52.8 |
| 85-89 | 0.0 | 0.0 | 0.7 | 24.5 | 38.4 | 0.0 | 63.5 | | | 36.5 | 36.5 |
| 90-94 | 0.0 | 0.0 | 0.0 | 35.5 | 34.0 | 0.3 | 69.8 | 2.7 | 13.0 | 20.7 | 30.2 |
| 95-97 | 0.0 | 0.0 | 0.1 | 9.8 | 0.8 | 0.0 | 10.7 | 0.2 | 57.7 | 31.5 | 89.3 |
| 85-94 | 0.0 | 0.0 | 0.4 | 30.0 | 36.2 | 0.1 | 66.7 | 2.7 | 13.0 | 28.6 | 33.3 |
| 85-97 | 0.0 | 0.0 | 0.3 | 25.3 | 28.0 | 0.1 | 53.7 | 1.4 | 35.3 | 29.3 | 46.3 |
| All | 0.0 | 0.0 | 0.2 | 20.2 | 31.5 | 0.1 | 51.9 | 1.4 | 35.3 | 35.8 | 48.1 |

* Rack sales and broodstock only separated in database since 1992. Inside brood includes spawning channel spawners.

Fraser Enhanced Stocks (Chilliwack, Chehalis, Blaney, Inch, Stave)

| Rtn Yr | Area 2-10 | Area 25-27 | Area 21-24 | Area 11-13 | Area 14-20 | Area 29 | Tot.Marine | Rack* | Brood* | Natural | Tot.Esc |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | 0.0 | 0.0 | 0.0 | 36.9 | 2.1 | 13.5 | 52.5 | | | 47.5 | 47.5 |
| 1981 | 0.0 | 0.0 | 0.0 | 4.2 | 0.5 | 0.9 | 5.6 | | | 94.4 | 94.4 |
| 1982 | 0.0 | 0.0 | 0.0 | 11.1 | 0.3 | 13.1 | 24.5 | | | 75.5 | 75.5 |
| 1983 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.1 | 1.0 | | | 99.0 | 99.0 |
| 1984 | 0.0 | 0.0 | 0.0 | 0.5 | 27.1 | 0.0 | 27.6 | | | 72.4 | 72.4 |
| 1985 | 0.0 | 0.0 | 0.2 | 11.4 | 0.3 | 3.1 | 15.0 | | | 85.0 | 85.0 |
| 1986 | 0.0 | 0.3 | 0.0 | 29.1 | 2.0 | 4.9 | 36.3 | | | 63.7 | 63.7 |
| 1987 | 0.0 | 0.0 | 1.1 | 3.6 | 2.7 | 1.3 | 8.8 | | | 91.2 | 91.2 |
| 1988 | 0.0 | 0.0 | 1.3 | 44.9 | 0.7 | 9.0 | 55.9 | | | 44.1 | 44.1 |
| 1989 | 0.0 | 0.0 | 1.1 | 24.8 | 0.5 | 2.3 | 28.7 | | | 71.3 | 71.3 |
| 1990 | 0.0 | 0.0 | 0.0 | 31.3 | 1.3 | 8.1 | 40.8 | | | 59.2 | 59.2 |
| 1991 | 0.0 | 0.0 | 0.5 | 6.1 | 3.4 | 6.1 | 16.1 | | | 83.9 | 83.9 |
| 1992 | 0.0 | 0.0 | 2.3 | 31.9 | 1.9 | 5.2 | 41.3 | 17.1 | 5.4 | 36.1 | 58.7 |
| 1993 | 0.3 | 0.0 | 0.2 | 24.4 | 2.3 | 6.2 | 33.3 | 13.0 | 5.9 | 47.7 | 66.7 |
| 1994 | 0.0 | 0.0 | 0.7 | 29.9 | 1.3 | 8.7 | 40.7 | 18.0 | 15.7 | 25.6 | 59.3 |
| 1995 | 0.0 | 0.0 | 0.3 | 11.4 | 0.9 | 12.4 | 24.9 | 31.8 | 10.0 | 33.3 | 75.1 |
| 1996 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 1.8 | 36.9 | 9.4 | 51.9 | 98.2 |
| 1997 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 | 0.0 | 2.9 | 45.9 | 8.7 | 42.5 | 97.1 |
| Annual Mean | | | | | | | | | | | |
| 80-84 | 0.0 | 0.0 | 0.0 | 10.7 | 6.0 | 5.5 | 22.2 | | | 77.8 | 77.8 |
| 85-89 | 0.0 | 0.1 | 0.7 | 22.8 | 1.2 | 4.1 | 28.9 | | | 71.1 | 71.1 |
| 90-94 | 0.1 | 0.0 | 0.7 | 24.7 | 2.0 | 6.9 | 34.4 | 16.0 | 9.0 | 50.5 | 65.6 |
| 95-97 | 0.0 | 0.0 | 0.1 | 5.4 | 0.3 | 4.1 | 9.9 | 38.2 | 9.4 | 42.5 | 90.1 |
| 85-94 | 0.0 | 0.0 | 0.7 | 23.7 | 1.6 | 5.5 | 31.7 | 16.0 | 9.0 | 60.8 | 68.3 |
| 85-97 | 0.0 | 0.0 | 0.6 | 19.5 | 1.3 | 5.2 | 26.7 | 27.1 | 9.2 | 56.6 | 73.3 |
| All | 0.0 | 0.0 | 0.4 | 17.1 | 2.6 | 5.3 | 25.4 | 27.1 | 9.2 | 62.5 | 74.6 |

* Rack sales and broodstock only separated in database since 1992.

Table 3.4 Fry-to-adult survivals of fed and unfed chum salmon fry released from SEP Operations major facilities (1978-1992 brood years)

FRY-TO-ADULT SURVIVAL BY BROOD YEAR (RECOVERIES TO 1997)

| HATCHERY | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | MEAN 78-92 | MEAN 78-82 | MEAN 83-87 | MEAN 88-92 | ODD 79-91 | EVEN 78-92 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **FED FRY RELEASES** | | | | | | | | | | | | | | | | | | | | |
| **NON-FRASER** | | | | | | | | | | | | | | | | TARGET SURVIVAL-1.5% | | | | | |
| PUNTLEDGE | | 1.64 | 0.21 | 3.23 | 2.21 | 1.89 | 0.20 | 0.47 | 1.79 | 1.08 | 1.86 | 1.91 | 1.38 | 0.30 | 0.18 | 1.31 | 1.82 | 1.09 | 1.13 | 1.50 | 1.12 |
| BIG QUALICUM | | | 0.12 | 1.87 | 3.21 | | | | | | | | | | | 1.73 | 1.73 | | | 1.87 | 1.67 |
| LITTLE QUALICUM | | | 0.25 | 2.34 | 3.29 | 1.32 | 0.87 | 0.76 | 0.74 | | | | | | | 1.37 | 1.96 | 0.92 | | 1.47 | 1.29 |
| NON-FRASER TOTAL | | 1.64 | 0.18 | 2.49 | 2.65 | 1.73 | 0.40 | 0.57 | 1.33 | 1.08 | 1.86 | 1.91 | 1.38 | 0.30 | 0.18 | 1.26 | 1.74 | 1.02 | 1.13 | 1.39 | 1.14 |
| **FRASER** | | | | | | | | | | | | | | | | | | | | | |
| CHILLIWACK | | | 0.19 | 1.25 | 2.62 | 1.27 | 2.24 | 0.78 | 1.34 | 0.92 | 2.30 | 3.76 | 2.17 | 0.74 | 0.62 | 1.55 | 1.35 | 1.31 | 1.92 | 1.45 | 1.91 |
| INCH | 0.54 | 0.54 | 0.59 | 1.40 | 0.43 | 0.74 | 0.79 | 0.32 | 0.66 | 0.45 | 1.61 | 1.01 | 2.04 | 1.30 | 0.31 | 0.85 | 0.70 | 0.59 | 1.25 | 0.82 | 1.00 |
| STAVE | | | | | 5.02 | 0.09 | 1.39 | 2.16 | 2.93 | 0.82 | 2.31 | 3.35 | 1.86 | 0.59 | 0.24 | 1.89 | 5.02 | 1.48 | 1.67 | 1.40 | 2.75 |
| BLANEY | 0.26 | 0.33 | 0.58 | 0.19 | 3.36 | 0.09 | 0.82 | 1.34 | 0.37 | | | | | | | 0.82 | 0.94 | 0.66 | | 0.49 | 1.08 |
| CHEHALIS | | | | | 2.74 | 0.28 | 1.03 | 1.05 | 1.86 | 0.62 | 0.82 | 0.84 | 0.85 | 0.44 | 0.21 | 0.98 | 2.74 | 0.97 | 0.63 | 0.64 | 1.50 |
| FRASER TOTAL | 0.50 | 0.50 | 0.42 | 1.00 | 2.69 | 0.35 | 1.23 | 1.18 | 1.90 | 0.69 | 1.36 | 1.90 | 1.29 | 0.55 | 0.29 | 1.06 | 1.02 | 1.07 | 1.08 | 0.88 | 1.38 |
| | **UNFED FRY RELEASES** | | | | | | | | | | | | | | | | | | | | |
| **NON-FRASER** | | | | | | | | | | | | | | | | TARGET SURVIVAL-0.7% | | | | | |
| BIG QUALICUM | 0.65 | 0.50 | 0.22 | 0.98 | 1.13 | 0.47 | 0.83 | 0.35 | 0.84 | 0.35 | 1.89 | 1.10 | 0.92 | 0.21 | 0.04 | 0.70 | 0.70 | 0.57 | 0.83 | 0.57 | 0.93 |
| LITTLE QUALICUM | | 0.68 | 0.21 | 0.46 | 1.28 | 0.33 | 0.32 | 0.39 | 0.37 | 0.18 | 0.81 | 0.81 | 0.56 | 0.15 | 0.02 | 0.47 | 0.66 | 0.32 | 0.47 | 0.43 | 0.59 |
| NON-FRASER TOTAL | 0.65 | 0.52 | 0.22 | 0.97 | 1.17 | 0.44 | 0.59 | 0.36 | 0.63 | 0.28 | 1.49 | 0.99 | 0.74 | 0.18 | 0.03 | 0.62 | 0.71 | 0.46 | 0.69 | 0.53 | 0.79 |

Table 3.5.1 Inner South Coast enhanced chum age composition by brood year for the catch and escapement of Inside Non-Fraser and Fraser stocl

**Non Fraser Enhanced Stocks (Puntledge, Big & Little Qualicum)**

| | Catch at Age | | | | | Escapement at Age | | | | | Catch + Escapement at Age | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Br.Yr.** | **2** | **3** | **4** | **5** | **6** | **2** | **3** | **4** | **5** | **6** | **2** | **3** | **4** | **5** | **6** |
| 1977 | 0.0 | 43.6 | 47.8 | 8.5 | 0.0 | 0.0 | 30.6 | 65.3 | 4.1 | 0.0 | 0.0 | 36.0 | 58.0 | 5.9 | 0.0 |
| 1978 | 0.0 | 3.7 | 89.0 | 7.3 | 0.0 | 0.0 | 9.5 | 80.0 | 10.6 | 0.0 | 0.0 | 6.1 | 85.1 | 8.7 | 0.0 |
| 1979 | 0.0 | 35.4 | 55.3 | 9.3 | 0.0 | 0.0 | 24.6 | 71.7 | 3.7 | 0.0 | 0.0 | 29.5 | 64.3 | 6.2 | 0.0 |
| 1980 | 0.0 | 12.8 | 83.0 | 4.2 | 0.0 | 0.0 | 34.2 | 65.8 | 0.0 | 0.0 | 0.0 | 23.0 | 74.8 | 2.2 | 0.0 |
| 1981 | 0.0 | 22.0 | 73.4 | 4.5 | 0.0 | 0.0 | 44.5 | 52.7 | 2.8 | 0.0 | 0.0 | 29.1 | 66.9 | 4.0 | 0.0 |
| 1982 | 0.0 | 33.1 | 62.3 | 4.3 | 0.3 | 0.0 | 36.1 | 56.2 | 7.3 | 0.4 | 0.0 | 34.2 | 60.1 | 5.4 | 0.3 |
| 1983 | 0.0 | 16.1 | 67.5 | 15.9 | 0.4 | 0.0 | 10.9 | 70.6 | 18.3 | 0.1 | 0.0 | 14.6 | 68.5 | 16.6 | 0.3 |
| 1984 | 0.0 | 4.8 | 75.3 | 19.9 | 0.1 | 0.0 | 2.1 | 77.2 | 20.7 | 0.0 | 0.0 | 3.6 | 76.1 | 20.3 | 0.0 |
| 1985 | 0.0 | 9.0 | 82.9 | 8.0 | 0.0 | 0.0 | 6.6 | 82.9 | 10.5 | 0.0 | 0.0 | 8.0 | 82.9 | 9.1 | 0.0 |
| 1986 | 0.0 | 6.1 | 63.4 | 29.5 | 1.0 | 0.0 | 10.7 | 70.3 | 18.8 | 0.2 | 0.0 | 7.5 | 65.4 | 26.3 | 0.8 |
| 1987 | 0.0 | 1.5 | 60.5 | 37.1 | 0.9 | 0.0 | 1.5 | 88.3 | 10.2 | 0.0 | 0.0 | 1.5 | 68.6 | 29.3 | 0.6 |
| 1988 | 0.0 | 0.9 | 74.3 | 23.6 | 1.2 | 0.0 | 11.1 | 54.9 | 33.1 | 0.8 | 0.0 | 3.1 | 70.2 | 25.6 | 1.1 |
| 1989 | 0.0 | 3.5 | 76.7 | 19.7 | 0.0 | 0.0 | 2.7 | 77.6 | 19.6 | 0.1 | 0.0 | 3.2 | 77.0 | 19.7 | 0.0 |
| 1990 | 0.0 | 7.6 | 87.9 | 4.5 | 0.0 | 0.0 | 4.4 | 80.7 | 14.9 | 0.1 | 0.0 | 6.3 | 85.1 | 8.6 | 0.0 |
| 1991 | 0.0 | 65.4 | 34.6 | 0.0 | 0.0 | 0.0 | 33.1 | 61.7 | 5.2 | 0.0 | 0.0 | 46.2 | 50.8 | 3.1 | 0.0 |
| **Total** | **0.0** | **12.6** | **71.2** | **15.7** | **0.5** | **0.0** | **18.3** | **67.7** | **13.7** | **0.2** | **0.0** | **14.6** | **70.0** | **15.0** | **0.4** |
| **Mean** | **0.0** | **17.7** | **68.9** | **13.1** | **0.3** | **0.0** | **17.5** | **70.4** | **12.0** | **0.1** | **0.0** | **16.8** | **70.3** | **12.7** | **0.2** |
| **Mn 81-90** | **0.0** | **10.5** | **72.4** | **16.7** | **0.4** | **0.0** | **13.1** | **71.1** | **15.6** | **0.2** | **0.0** | **11.1** | **72.1** | **16.5** | **0.3** |

**Fraser Enhanced Stocks (Chilliwack, Chehalis, Blaney, Inch, Stave)**

| | Catch at Age | | | | | Escapement at Age | | | | | Catch + Escapement at Age | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Br.Yr.** | **2** | **3** | **4** | **5** | **6** | **2** | **3** | **4** | **5** | **6** | **2** | **3** | **4** | **5** | **6** |
| 1977 | 0.0 | 80.6 | 9.0 | 10.4 | 0.0 | 0.0 | 36.3 | 58.5 | 5.1 | 0.0 | 0.0 | 51.1 | 42.0 | 6.9 | 0.0 |
| 1978 | 0.0 | 0.1 | 99.5 | 0.4 | 0.0 | 0.0 | 26.5 | 71.4 | 2.0 | 0.0 | 0.0 | 21.0 | 77.3 | 1.7 | 0.0 |
| 1979 | 0.0 | 92.5 | 7.5 | 0.0 | 0.0 | 0.0 | 56.3 | 42.7 | 1.0 | 0.0 | 0.0 | 60.4 | 38.7 | 0.9 | 0.0 |
| 1980 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 62.0 | 37.3 | 0.7 | 0.0 | 0.0 | 45.7 | 53.8 | 0.5 | 0.0 |
| 1981 | 0.0 | 11.0 | 58.5 | 30.5 | 0.0 | 0.0 | 14.3 | 82.5 | 3.2 | 0.0 | 0.0 | 13.5 | 76.9 | 9.6 | 0.0 |
| 1982 | 0.0 | 13.2 | 84.3 | 2.4 | 0.2 | 0.0 | 33.3 | 62.4 | 4.3 | 0.0 | 0.0 | 27.4 | 68.8 | 3.7 | 0.1 |
| 1983 | 0.0 | 32.3 | 32.3 | 35.2 | 0.1 | 0.0 | 10.4 | 81.8 | 7.8 | 0.0 | 0.0 | 13.8 | 74.0 | 12.2 | 0.0 |
| 1984 | 0.0 | 0.5 | 92.4 | 7.0 | 0.1 | 0.0 | 11.9 | 80.2 | 7.8 | 0.1 | 0.0 | 5.3 | 87.2 | 7.4 | 0.1 |
| 1985 | 0.0 | 38.4 | 58.6 | 3.0 | 0.0 | 0.0 | 23.7 | 73.9 | 2.4 | 0.0 | 0.0 | 28.6 | 68.8 | 2.6 | 0.0 |
| 1986 | 0.0 | 7.6 | 82.3 | 10.1 | 0.1 | 0.0 | 14.4 | 64.5 | 20.9 | 0.2 | 0.0 | 12.0 | 70.8 | 17.1 | 0.2 |
| 1987 | 0.0 | 5.3 | 62.1 | 32.6 | 0.0 | 0.0 | 1.7 | 86.9 | 11.3 | 0.1 | 0.0 | 2.7 | 80.1 | 17.1 | 0.1 |
| 1988 | 0.0 | 0.7 | 86.3 | 12.9 | 0.1 | 0.0 | 17.6 | 72.6 | 9.7 | 0.2 | 0.0 | 11.1 | 77.9 | 10.9 | 0.1 |
| 1989 | 0.0 | 9.6 | 79.1 | 11.2 | 0.1 | 0.0 | 10.8 | 82.0 | 7.1 | 0.0 | 0.0 | 10.4 | 81.1 | 8.4 | 0.1 |
| 1990 | 0.0 | 12.1 | 79.8 | 8.1 | 0.0 | 0.0 | 10.8 | 73.7 | 15.3 | 0.1 | 0.0 | 11.3 | 76.0 | 12.6 | 0.1 |
| 1991 | 0.0 | 37.1 | 61.6 | 1.3 | 0.0 | 0.0 | 18.7 | 70.4 | 10.9 | 0.0 | 0.0 | 24.6 | 67.6 | 7.8 | 0.0 |
| **Total** | **0.0** | **12.0** | **78.8** | **9.1** | **0.1** | **0.0** | **17.7** | **72.6** | **9.6** | **0.1** | **0.0** | **15.7** | **74.8** | **9.4** | **0.1** |
| **Mean** | **0.0** | **22.7** | **66.2** | **11.0** | **0.0** | **0.0** | **23.2** | **69.4** | **7.3** | **0.1** | **0.0** | **22.6** | **69.4** | **8.0** | **0.0** |
| **Mn 81-90** | **0.0** | **13.1** | **71.6** | **15.3** | **0.1** | **0.0** | **14.9** | **76.0** | **9.0** | **0.1** | **0.0** | **13.6** | **76.1** | **10.2** | **0.1** |

**Study Area Enhanced Stocks (Puntledge, Big & Little Qualicum, Chilliwack, Chehalis, Blaney, Inch, Stave)**

| | Catch at Age | | | | | Escapement at Age | | | | | Catch + Escapement at Age | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Br.Yr.** | **2** | **3** | **4** | **5** | **6** | **2** | **3** | **4** | **5** | **6** | **2** | **3** | **4** | **5** | **6** |
| 1977 | 0.0 | 45.2 | 46.2 | 8.6 | 0.0 | 0.0 | 31.0 | 64.9 | 4.1 | 0.0 | 0.0 | 36.8 | 57.2 | 6.0 | 0.0 |
| 1978 | 0.0 | 3.7 | 89.1 | 7.3 | 0.0 | 0.0 | 10.0 | 79.7 | 10.3 | 0.0 | 0.0 | 6.4 | 85.0 | 8.6 | 0.0 |
| 1979 | 0.0 | 35.7 | 55.1 | 9.2 | 0.0 | 0.0 | 25.6 | 70.8 | 3.6 | 0.0 | 0.0 | 30.0 | 63.9 | 6.1 | 0.0 |
| 1980 | 0.0 | 12.5 | 83.3 | 4.1 | 0.0 | 0.0 | 36.0 | 63.9 | 0.0 | 0.0 | 0.0 | 24.0 | 73.9 | 2.1 | 0.0 |
| 1981 | 0.0 | 21.6 | 72.9 | 5.5 | 0.0 | 0.0 | 38.0 | 59.1 | 2.9 | 0.0 | 0.0 | 27.5 | 67.9 | 4.5 | 0.0 |
| 1982 | 0.0 | 30.2 | 65.5 | 4.0 | 0.3 | 0.0 | 34.9 | 58.8 | 6.0 | 0.2 | 0.0 | 32.4 | 62.4 | 5.0 | 0.2 |
| 1983 | 0.0 | 16.7 | 66.4 | 16.6 | 0.4 | 0.0 | 10.8 | 73.9 | 15.2 | 0.1 | 0.0 | 14.5 | 69.2 | 16.1 | 0.3 |
| 1984 | 0.0 | 2.6 | 83.8 | 13.5 | 0.1 | 0.0 | 6.9 | 78.7 | 14.3 | 0.0 | 0.0 | 4.5 | 81.6 | 13.9 | 0.1 |
| 1985 | 0.0 | 25.0 | 69.7 | 5.3 | 0.0 | 0.0 | 19.8 | 75.9 | 4.3 | 0.0 | 0.0 | 22.0 | 73.3 | 4.7 | 0.0 |
| 1986 | 0.0 | 6.5 | 68.3 | 24.4 | 0.8 | 0.0 | 13.0 | 66.8 | 20.0 | 0.2 | 0.0 | 9.3 | 67.7 | 22.5 | 0.5 |
| 1987 | 0.0 | 2.1 | 60.7 | 36.5 | 0.8 | 0.0 | 1.6 | 87.6 | 10.8 | 0.0 | 0.0 | 1.9 | 72.1 | 25.6 | 0.5 |
| 1988 | 0.0 | 0.9 | 75.3 | 22.7 | 1.1 | 0.0 | 13.5 | 61.3 | 24.6 | 0.6 | 0.0 | 4.4 | 71.5 | 23.2 | 1.0 |
| 1989 | 0.0 | 4.7 | 77.2 | 18.0 | 0.0 | 0.0 | 7.0 | 80.0 | 13.0 | 0.1 | 0.0 | 5.7 | 78.4 | 15.8 | 0.1 |
| 1990 | 0.0 | 8.5 | 86.3 | 5.2 | 0.0 | 0.0 | 6.9 | 77.9 | 15.1 | 0.1 | 0.0 | 7.8 | 82.5 | 9.7 | 0.0 |
| 1991 | 0.0 | 53.6 | 45.9 | 0.6 | 0.0 | 0.0 | 25.8 | 66.2 | 8.1 | 0.0 | 0.0 | 35.9 | 58.8 | 5.3 | 0.0 |
| **Total** | **0.0** | **12.5** | **72.5** | **14.6** | **0.4** | **0.0** | **18.1** | **69.8** | **12.0** | **0.2** | **0.0** | **14.9** | **71.3** | **13.5** | **0.3** |
| **Mean** | **0.0** | **18.0** | **69.7** | **12.1** | **0.2** | **0.0** | **18.7** | **71.0** | **10.2** | **0.1** | **0.0** | **17.5** | **71.0** | **11.3** | **0.2** |
| **Mn 81-90** | **0.0** | **11.9** | **72.6** | **15.2** | **0.3** | **0.0** | **15.2** | **72.0** | **12.6** | **0.1** | **0.0** | **13.0** | **72.7** | **14.1** | **0.3** |

Table 3.5.2 Inner South Coast chum age composition by brood year for Inside Non-Fraser and Fraser stocks.

| Br.Yr. | Catch + Escapement at Age | | | | |
|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 |
| **Inside Non Fraser Stocks** | | | | | |
| Enhanced | 0.0 | 11.1 | 72.1 | 16.5 | 0.3 |
| Enh+Wild | 0.0 | 12.4 | 71.6 | 16.0 | 0.0 |
| **Fraser Stocks** | | | | | |
| Enhanced | 0.0 | 13.6 | 76.1 | 10.2 | 0.1 |
| Enh+Wild | 0.0 | 12.1 | 69.7 | 18.2 | 0.0 |
| **Study Area Stocks** | | | | | |
| Enhanced | 0.0 | 13.0 | 72.6 | 14.1 | 0.3 |
| Enh+Wild | 0.0 | 12.2 | 71.0 | 16.8 | 0.0 |

Table 4.1. Average total escapement, wild escapement, and enhancement contribution by major geographic areas for Inner South Coast (ISC) chum salmon stocks from 1953 to 1997. ISC includes Inside Study Area (ISA), Seymour/ Belize Inlets and Summer chum stocks. Total escapement includes natural river spawners (wild and enhanced), hatchery broodstock, and hatchery rack sale. Total non-enhanced is total escapement from non-enhanced systems. Total enhanced is total escapement from enhanced systems. Listed stocks have at least one escapement record. Target is the target escapement for each system. N is the number of years of data available for each system (maximum is 45 years). Systems surveyed are the number of systems surveyed in each region or time period.

| | | | | AVERAGE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REGION/SYSTEM | TARGET | SOURCE | N | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **SEYMOUR/BELIZE INLETS** | | | | | | | | | |
| ALLISON RIVER | 1500 | Wild | 4 | 16 | 180 | | | | 43 |
| BAMFORD CREEK | 2000 | Wild | 26 | | 38 | 508 | 123 | 704 | 258 |
| CHIEF NOWLEY CREEK | 1500 | Wild | 25 | 6 | 55 | 106 | 30 | 789 | 166 |
| DRIFTWOOD CREEK | 20000 | Wild | 42 | 1056 | 2295 | 6720 | 2753 | 3679 | 3375 |
| EVA CREEK | 3500 | Wild | 25 | 88 | 140 | 758 | 150 | 700 | 357 |
| JAP CREEEK | 20000 | Wild | 40 | 483 | 1940 | 4158 | 995 | 736 | 1776 |
| LASSITER AND ROWLEY CREEKS | 500 | Wild | 8 | | 10 | 21 | 3 | 43 | 14 |
| NUGENT CREEK | 200 | Wild | 7 | | 4 | 3 | | 43 | 8 |
| PACK LAKE CREEK | 3500 | Wild | 21 | 906 | 100 | 5 | 45 | 2143 | 528 |
| QUASHELLA RIVER | 10000 | Wild | 36 | 918 | 3427 | 1411 | 123 | 729 | 1379 |
| RAINBOW CREEK | 5000 | Wild | 43 | 296 | 661 | 1361 | 608 | 1050 | 800 |
| SCHWARTZENBERG LAGOON CRE | 300 | Wild | 1 | | 10 | | | | 2 |
| SEYMOUR RIVER | 20000 | Wild | 45 | 5169 | 6498 | 6425 | 3825 | 5107 | 5435 |
| TAALTZ CREEK | 45000 | Wild | 44 | 4069 | 8501 | 15140 | 13350 | 15000 | 11277 |
| WAAMTX CREEK | 3500 | Wild | 37 | 172 | 126 | 565 | 33 | 1857 | 480 |
| WARNER BAY CREEK | 3500 | Wild | 43 | 778 | 605 | 1535 | 648 | 2486 | 1144 |
| WAUMP CREEK | 18000 | Wild | 43 | 2045 | 4355 | 5920 | 1405 | 2118 | 3289 |
| WAWWATL CREEK | 5500 | Wild | 6 | 999 | | | | 4 | 178 |
| WODEFORD CREEK | 1500 | Wild | 2 | | | | | 271 | 42 |
| | 165000 | Wild | | 13232 | 20085 | 29585 | 19260 | 26843 | 21845 |
| | | | 19 | 10 | 11 | 11 | 10 | 14 | 11 |

| | | | | AVERAGE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REGION/SYSTEM | TARGET | | N | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **UPPER VANCOUVER ISLAND** | | | | | | | | | |
| CLUXEWE RIVER | 5,000 | Wild | 36 | 94 | 83 | 152 | 830 | 2,357 | 620 |
| KEOGH RIVER | 15,000 | Wild | 28 | 6 | 53 | 436 | 2,145 | 4,279 | 1,252 |
| NAHWITTI RIVER | 5,000 | Wild | 17 | 95 | | 77 | 278 | 868 | 231 |
| QUATSE RIVER | 10,000 | Wild | 41 | 231 | 161 | 454 | 5,065 | 10,143 | 2,881 |
| SHUSHARTIE RIVER | 1,500 | Wild | 18 | 9 | | 27 | 275 | 682 | 175 |
| SONGHEES CREEK | 500 | Wild | 10 | 47 | | 3 | 63 | 300 | 69 |
| STRANBY RIVER | 25,000 | Wild | 8 | 9 | | 75 | 20 | 3,643 | 589 |
| TSULQUATE RIVER | 5,000 | Wild | 30 | 84 | 51 | 177 | 585 | 1,004 | 352 |
| TOTAL | 67,000 | | | 575 | 347 | 1,399 | 9,260 | 23,275 | 6,169 |
| SYSTEMS SURVEYED | | | 8 | 3 | 2 | 4 | 6 | 7 | 4 |

Table 4.1. Continued

| | | | | AVERAGE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REGION/SYSTEM | TARGET | | N | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **KINGCOME INLET** | | | | | | | | | |
| BUGHOUSE CREEK | 500 | Wild | 3 | | | | | 718 | 112 |
| CHARLES CREEK | 500 | Wild | 8 | 3 | 2 | | | 393 | 62 |
| COHOE CREEK | | Wild | 1 | | | 1 | | | 0 |
| EMBLEY CREEK | | Wild | 7 | | 51 | | | 929 | 156 |
| HUASKIN CREEK | 500 | Wild | 17 | | 114 | 325 | 20 | | 102 |
| JENNIS BAY CREEK | 1,000 | Wild | 3 | | 8 | | 3 | | 2 |
| KENNETH RIVER | 500 | Wild | 1 | | 5 | | | | 1 |
| KINGCOME RIVER | 150,000 | Wild | 40 | 1,293 | 2,738 | 22,270 | 11,200 | 12,286 | 10,187 |
| MACKENZIE SOUND CREEK | 6,000 | Wild | 41 | 232 | 2,690 | 6,610 | 2,145 | 4,250 | 3,246 |
| MARION CREEK | 5,000 | Wild | 36 | 25 | 1,933 | 3,170 | 390 | 3,914 | 1,834 |
| NIMMO CREEK | 5,000 | Wild | 38 | 44 | 358 | 2,415 | 1,765 | 5,893 | 1,933 |
| SCOTT COVE CREEK | 5,000 | Wild | 28 | 7 | 230 | 90 | 20 | 575 | 166 |
| SHELTER BAY CREEK | 1,000 | Wild | 4 | | 0 | | | 11 | 2 |
| SIMOON SOUND CREEK | | Wild | 17 | 3 | 18 | 70 | 45 | 443 | 99 |
| SULLIVAN BAY CREEK | | Wild | 5 | | | | | 18 | 3 |
| WAKEMAN RIVER | 25,000 | Wild | 41 | 288 | 2,307 | 5,055 | 2,450 | 6,857 | 3,298 |
| TOTAL | 200,000 | | | 1,893 | 10,451 | 40,006 | 18,038 | 36,286 | 21,202 |
| SYSTEMS SURVEYED | | | 16 | 3 | 8 | 7 | 6 | 10 | 6 |

| | | | | AVERAGE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REGION/SYSTEM | TARGET | | N | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **BOND/KNIGHT INLETS** | | | | | | | | | |
| AHTA RIVER | 20,000 | Wild | 45 | 1,216 | 3,498 | 11,520 | 9,820 | 10,929 | 7,436 |
| AHTA VALLEY CREEK | 20,000 | Wild | 24 | 1 | 85 | 340 | 490 | 3,071 | 681 |
| BOUGHEY CREEK | 100 | Wild | 12 | 25 | 27 | | 48 | 86 | 34 |
| CALL CREEK | 600 | Wild | 37 | 137 | 365 | 1,708 | 570 | 829 | 741 |
| CRACROFT CREEK | 100 | Wild | 1 | | | | | 4 | 1 |
| FRANKLIN RIVER | 3,000 | Wild | 21 | | | 325 | 805 | 1,521 | 488 |
| GILFORD CREEK | 300 | Wild | 27 | | 15 | 110 | 170 | 593 | 158 |
| GLENDALE CREEK | 75,000 | Wild | 44 | 3,352 | 1,880 | 9,730 | 18,858 | 4,929 | 8,133 |
| HOEYA SOUND CREEK | 100 | Wild | 14 | 5 | | | 125 | 632 | 127 |
| KAKWEIKEN RIVER | 75,000 | Wild | 43 | 1,160 | 1,945 | 4,120 | 3,100 | 10,557 | 3,885 |
| KAMANO BAY CREEK | 100 | Wild | 5 | | | | | 200 | 31 |
| KLINAKLINI RIVER | 100,000 | Wild | 34 | 327 | 100 | 11,500 | 9,408 | 17,429 | 7,438 |
| KWALATE CREEK | 300 | Wild | 32 | 45 | 106 | 50 | 138 | 443 | 142 |
| LULL CREEK | 100 | Wild | 31 | 13 | 7 | 185 | 230 | 782 | 218 |
| MAPLE CREEK | 100 | Wild | 3 | | | | | 61 | 9 |
| MATSIU CREEK | 100 | Wild | 9 | 6 | 40 | | 3 | 75 | 22 |
| MCALISTER CREEK | | Wild | 11 | 1 | 5 | 20 | | | 6 |
| NIGGER CREEK | | Wild | 8 | | | | 15 | 21 | 7 |
| PORT HARVEY LAGOON CREEKS | | Wild | 8 | | | | 33 | 39 | 13 |
| PROTECTION POINT CREEK | | Wild | 9 | | | | 10 | 71 | 13 |
| SHOAL CREEK | 100 | Wild | 7 | | | | 75 | 21 | 20 |
| SHOAL HARBOUR CREEK | 1,000 | Wild | 43 | 45 | 1,195 | 1,163 | 1,800 | 6,000 | 1,865 |
| SIM RIVER | 10,000 | Wild | 24 | 34 | 126 | 31 | 1,028 | 1,807 | 550 |
| VINER SOUND CREEK | 40,000 | Wild | 45 | 4,138 | 25,420 | 27,500 | 30,640 | 55,000 | 27,860 |
| WAHKANA BAY CREEK | | Wild | 24 | 0 | 5 | 13 | 53 | 911 | 157 |
| TOTAL | 346,000 | | | 10,506 | 34,819 | 68,313 | 77,415 | 116,011 | 60,035 |
| SYSTEMS SURVEYED | | | 24 | 8 | 10 | 11 | 15 | 20 | 12 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **JOHNSTONE STRAIT** | | | | | | | | | |
| ADAM RIVER | 5,000 | Wild | 18 | 188 | | 75 | 845 | 2,929 | 693 |
| AMOR DE COSMOS CREEK | 10,000 | Wild | 33 | 22 | 68 | 678 | 358 | 443 | 318 |
| FULMORE RIVER | 10,000 | Wild | 38 | 2,675 | 2,065 | 1,175 | 900 | 2,821 | 1,834 |
| HYACINTHE BAY CREEK | 10,000 | Wild | 44 | 783 | 2,780 | 2,800 | 1,620 | 3,000 | 2,206 |
| HYDE CREEK | 3,500 | Wild | 9 | 3 | | 60 | 7 | | 15 |
| KOKISH RIVER | 5,000 | Wild | 32 | 179 | 1 | 133 | 370 | 1,964 | 449 |
| MILLS CREEK | 2,500 | Wild | 25 | 51 | 131 | 16 | 163 | 761 | 196 |
| NEW VANCOUVER CREEK | | Wild | 4 | | | | | 14 | 2 |
| NIMPKISH RIVER | 110,000 | Wild | 45 | 67,459 | 42,365 | 12,700 | 24,250 | 42,857 | 36,285 |
| POTTS LAGOON CREEK | | Wild | 8 | 3 | | | | 39 | 7 |
| ROBBERS KNOB CREEK | 500 | Wild | 10 | | | | 8 | 32 | 7 |
| SALMON RIVER | 20,000 | Wild | 35 | 94 | 122 | 860 | 1,455 | 3,964 | 1,175 |
| TSITIKA RIVER | 10,000 | Wild | 10 | | | 70 | 28 | 1,071 | 188 |
| TUNA RIVER | 3,500 | Wild | 25 | 44 | 175 | 73 | 115 | 757 | 206 |
| WALDON CREEK | | Wild | 4 | | | | | 21 | 3 |
| TOTAL | 190,000 | | | 71,500 | 47,706 | 18,638 | 30,117 | 60,675 | 43,585 |
| SYSTEMS SURVEYED | | | 14 | 5 | 5 | 7 | 9 | 13 | 8 |

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **LOUGHBOROUGH/BUTE INLETS** | | | | | | | | | |
| APPLE RIVER | 20,000 | Wild | 36 | 247 | 3,260 | 7,300 | 1,330 | 689 | 2,793 |
| BACHUS CREEK | | Wild | 2 | | 7 | | | | 1 |
| BIRD COVE CREEK | 200 | Wild | 36 | 51 | 425 | 865 | 728 | 207 | 490 |
| CAMELEON HARBOUR CREEK | 100 | Wild | 33 | 23 | 25 | 25 | 158 | 243 | 88 |
| CHONAT CREEK | | Wild | 8 | | | | 3 | 25 | 4 |
| CHRISTIE CREEK | 100 | Wild | 41 | 78 | 360 | 453 | 655 | 46 | 347 |
| CUMSACK RIVER | 100 | Wild | 14 | | | 3 | 313 | 1,464 | 298 |
| DREW CREEK | 100 | Wild | 21 | 16 | 20 | 18 | 5 | 146 | 35 |
| ELEPHANT CREEK | 100 | Wild | 2 | | 35 | | | | 8 |
| FANNY BAY CREEK | 100 | Wild | 11 | 9 | 1 | 40 | 3 | 61 | 21 |
| FORD CREEK | 100 | Wild | 5 | 2 | | | | 18 | 3 |
| FRASER BAY CREEK | 100 | Wild | 33 | 51 | 91 | 328 | 130 | 143 | 153 |
| FREDERICK CREEK | 100 | Wild | 12 | | | | 163 | 189 | 66 |
| GRANITE BAY CREEK | 100 | Wild | 44 | 383 | 897 | 303 | 508 | 414 | 512 |
| GRASSY CREEK | 100 | Wild | 25 | 288 | 18 | 68 | 58 | 36 | 88 |
| GRAY CREEK | 100 | Wild | 22 | 429 | 35 | | 80 | 29 | 106 |
| HANSEN CREEK | 100 | Wild | 28 | | 318 | 198 | 223 | 118 | 182 |
| HEMMING BAY CREEK | 100 | Wild | 23 | 53 | 52 | | 58 | 246 | 72 |
| HEYDON CREEK | 35,000 | Wild | 43 | 3,500 | 13,570 | 18,825 | 10,475 | 7,200 | 11,269 |
| HOMATHKO RIVER | 100,000 | Wild | 45 | 9,750 | 14,425 | 20,100 | 3,260 | 16,029 | 12,623 |
| KANISH CREEK | 100 | Wild | 42 | 63 | 891 | 360 | 543 | 421 | 475 |
| KNOX BAY CREEK | 100 | Wild | 16 | 3 | | 23 | 70 | 39 | 27 |
| OPEN BAY CREEK | 200 | Wild | 42 | 675 | 1,683 | 918 | 1,003 | 732 | 1,035 |
| OWEN CREEK | 100 | Wild | 2 | | 8 | | | | 2 |
| PHILLIPS RIVER | 20,000 | Wild | 45 | 1,463 | 1,365 | 4,275 | 2,605 | 3,843 | 2,690 |
| QUATAM RIVER | 300 | Wild | 38 | 1,297 | 593 | 2,565 | 1,165 | 3,079 | 1,670 |
| READ CREEK | 100 | Wild | 38 | 123 | 242 | 705 | 998 | 629 | 552 |
| SOUTHGATE RIVER | 250,000 | Wild | 44 | 66,875 | 106,700 | 36,200 | 6,650 | 7,429 | 46,278 |
| STAFFORD RIVER | 4,000 | Wild | 35 | 6,888 | 203 | 1,180 | 1,368 | 768 | 1,955 |
| TEAQUAHAN RIVER | 100 | Wild | 23 | 144 | 305 | 40 | 350 | 1,179 | 363 |
| THURSTON BAY CREEK | 100 | Wild | 37 | 29 | 233 | 195 | 365 | 96 | 196 |
| VILLAGE BAY CREEK | 5,000 | Wild | 41 | 396 | 2,030 | 1,730 | 1,125 | 2,950 | 1,615 |
| WAIATT BAY CREEK | 100 | Wild | 41 | 79 | 138 | 123 | 128 | 114 | 118 |
| WHITEROCK PASS CREEK | 100 | Wild | 37 | 16 | 94 | 220 | 145 | 129 | 125 |
| WORTLEY CREEK | 100 | Wild | 41 | 531 | 2,380 | 210 | 283 | 175 | 760 |
| TOTAL | 437,000 | | | 93,460 | 150,400 | 97,265 | 34,940 | 48,886 | 87,021 |
| SYSTEMS SURVEYED | | | 35 | 18 | 20 | 21 | 26 | 29 | 22 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **MID VANCOUVER ISLAND** | | | | | | | | | |
| BOB CREEK | 200 | Wild | 11 | 152 | 14 | | | | 30 |
| CABIN CREEK | 200 | Wild | 3 | 8 | 30 | | | | 8 |
| CAMPBELL RIVER | 10,000 | Wild | 43 | 6,313 | 3,555 | 4,820 | 1,305 | 1,414 | 3,493 |
| CHEF CREEK | 5,000 | Wild | 45 | 1,925 | 3,265 | 4,065 | 1,630 | 3,286 | 2,844 |
| COWIE CREEK | 2,000 | Wild | 43 | 398 | 369 | 307 | 755 | 2,429 | 766 |
| ENGLISHMAN RIVER | 4,000 | Wild | 45 | 2,756 | 1,620 | 4,825 | 3,575 | 8,321 | 4,011 |
| FRENCH CREEK | 1,000 | Wild | 34 | 63 | 60 | 450 | 500 | 936 | 381 |
| HART CREEK | 500 | Wild | 13 | 73 | 3 | 18 | | | 18 |
| KINGFISHER CREEK | 200 | Wild | 1 | | 1 | | | | 0 |
| KITTY COLEMAN CREEK | 300 | Wild | 2 | | | 5 | | | 1 |
| LITTLE QUALICUM RIVER | 130,000 | Wild | 45 | 72,563 | 54,472 | 53,250 | 42,500 | 35,000 | 51,727 |
| LYMN CREEK | 200 | Wild | 30 | 87 | 37 | 45 | 56 | 104 | 62 |
| MCNAUGHTON CREEK | 2,000 | Wild | 45 | 481 | 802 | 1,900 | 863 | 5,214 | 1,689 |
| MENZIES CREEK | 800 | Wild | 39 | 19 | 126 | 230 | 390 | 554 | 255 |
| MILLARD CREEK | 200 | Wild | 13 | 174 | 41 | | | | 40 |
| MOHUN CREEK | 800 | Wild | 36 | 125 | 524 | 208 | 245 | 546 | 324 |
| MORRISON CREEK | 200 | Wild | 22 | 2,075 | 555 | | | 54 | 501 |
| NILE CREEK | 1,000 | Wild | 43 | 556 | 84 | 65 | 143 | 186 | 193 |
| OYSTER RIVER | 3,500 | Wild | 41 | 1,025 | 72 | 460 | 483 | 5,500 | 1,263 |
| PUNTLEDGE RIVER | 60,000 | Wild | 44 | 56,839 | 59,976 | 40,600 | 33,400 | 32,143 | 44,877 |
| PYE CREEK | 500 | Wild | 24 | 1 | 68 | 33 | 113 | 100 | 63 |
| QUALICUM RIVER | | Wild | 5 | | | | | 22,143 | 3,444 |
| QUINSAM RIVER | 2,000 | Wild | 38 | 171 | 467 | 651 | 480 | 743 | 501 |
| ROSEWALL CREEK | 200 | Wild | 41 | 713 | 1,168 | 1,070 | 1,775 | 2,929 | 1,474 |
| ROY CREEK | 300 | Wild | 11 | 78 | 6 | | | | 15 |
| SHAW CREEK | | Wild | 1 | 25 | | | | | 4 |
| SIMMS CREEK | | Wild | 2 | 1 | | | | | 0 |
| STORIE CREEK | | Wild | 1 | | 1 | | | | 0 |
| TRENT RIVER | 1,400 | Wild | 36 | 738 | 435 | 850 | 183 | | 457 |
| TSABLE RIVER | 7,000 | Wild | 43 | 2,025 | 2,205 | 4,970 | 6,525 | 8,000 | 4,649 |
| TSOLUM RIVER | 1,500 | Wild | 36 | 1,250 | 3,008 | 118 | 768 | 636 | 1,186 |
| WATERLOO CREEK | 2,000 | Wild | 43 | 88 | 145 | 385 | 560 | 1,807 | 539 |
| WILFRED CREEK | 2,500 | Wild | 45 | 382 | 493 | 990 | 868 | 1,475 | 820 |
| WOODS | | Wild | 1 | | 2 | | | | 0 |
| TOTAL | 239,500 | | | 151,100 | 133,600 | 120,313 | 97,113 | 133,518 | 125,637 |
| SYSTEMS SURVEYED | | | 33 | 23 | 20 | 20 | 20 | 21 | 21 |

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **TOBA INLET** | | | | | | | | | |
| BREM RIVER | 15,000 | Wild | 33 | 46 | 33 | 1,255 | 1,480 | 3,457 | 1,161 |
| BREM RIVER TRIBUTARY | | Wild | 7 | 1 | | | | 21 | 4 |
| FILER CREEK | | Wild | 1 | | | 3 | | | 1 |
| FORBES BAY CREEK | 5,000 | Wild | 36 | 12 | 129 | 341 | 197 | 529 | 233 |
| FORBES CREEK | | Wild | 36 | 18 | 270 | 859 | 525 | 3,429 | 904 |
| KLITE RIVER | 15,000 | Wild | 31 | 8 | 290 | 1,085 | 2,515 | 2,393 | 1,238 |
| LITTLE TOBA RIVER | 20,000 | Wild | 26 | | 750 | 1,700 | 2,598 | 821 | 1,249 |
| OKEOVER CREEK | 6,000 | Wild | 41 | 245 | 3,941 | 2,144 | 803 | 839 | 1,705 |
| PENDRELL SOUND CREEK | | Wild | 30 | 14 | 135 | 106 | 278 | 300 | 164 |
| REFUGE COVE LAGOON CREEK | | Wild | 17 | | | 10 | 90 | 111 | 39 |
| SALT LAGOON CREEK | | Wild | 21 | | | 43 | 98 | 536 | 114 |
| STORE CREEK | | Wild | 4 | | 100 | 27 | | | 28 |
| TAHUMMING RIVER | | Wild | 18 | | | 40 | 53 | 225 | 56 |
| THEODOSIA RIVER | 21,000 | Wild | 40 | 396 | 2,205 | 3,755 | 5,850 | 17,071 | 5,350 |
| TOBA RIVER | 90,000 | Wild | 30 | | 2,180 | 4,350 | 7,250 | 22,500 | 6,562 |
| TWIN RIVERS | | Wild | 1 | | | 56 | | | 12 |
| TOTAL | 172,000 | | | 740 | 10,033 | 15,772 | 21,735 | 52,232 | 18,821 |
| SYSTEMS SURVEYED | | | 15 | 3 | 6 | 9 | 12 | 12 | 8 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **JERVIS INLET** | | | | | | | | | |
| ANGUS CREEK | 2,000 | Wild | 45 | 391 | 1,290 | 1,149 | 2,600 | 1,411 | 1,409 |
| BAKER CREEK | | Wild | 10 | 2 | 25 | 36 | | | 14 |
| BISHOP CREEK | 12,000 | Wild | 40 | 1,423 | 7,373 | 11,936 | 12,550 | 5,214 | 8,144 |
| BRITTAIN RIVER | 5,000 | Wild | 44 | 459 | 247 | 243 | 676 | 1,129 | 516 |
| BURNET CREEK | | Wild | 13 | 7 | 120 | 4 | | | 29 |
| CARLSON CREEK | 1,000 | Wild | 40 | 35 | 557 | 408 | 1,353 | 493 | 598 |
| CRANBY CREEK | | Wild | 7 | 0 | 2 | 33 | | | 8 |
| DAYTON CREEK | | Wild | 40 | 16 | 532 | 760 | 380 | 207 | 407 |
| DESERTED RIVER | 25,000 | Wild | 45 | 35,250 | 20,050 | 18,450 | 6,100 | 10,786 | 17,856 |
| DORISTON CREEK | | Wild | 40 | 238 | 430 | 65 | 59 | 82 | 178 |
| EARLE CREEK | | Wild | 5 | 3 | 80 | 20 | | | 23 |
| GRAY CREEK | 1,000 | Wild | 40 | 17 | 288 | 461 | 692 | 1,121 | 498 |
| HALFMOON CREEK | | Wild | 11 | 33 | 69 | 8 | | | 23 |
| HIGH CREEK | | Wild | 1 | | 5 | | | | 1 |
| HUNAECHIN CREEK | | Wild | 12 | 1,219 | 450 | | | | 317 |
| JEFFERD CREEK | 1,600 | Wild | 42 | 726 | 1,407 | 1,095 | 165 | 914 | 864 |
| KELLY CREEK | | Wild | 41 | 632 | 1,845 | 893 | 193 | 468 | 836 |
| LANG CREEK | 2,500 | Wild | 44 | 11,276 | 2,220 | 1,992 | 2,815 | 4,714 | 4,299 |
| LOIS RIVER | | Wild | 41 | 105 | 442 | 245 | 233 | 268 | 265 |
| MILL CREEK | | Wild | 1 | | 1 | | | | 0 |
| MOUAT CREEK | | Wild | 8 | | 95 | 263 | 600 | | 213 |
| MYRTLE CREEK | | Wild | 41 | 20 | 510 | 547 | 365 | 414 | 384 |
| PARK CREEK | | Wild | 3 | | 523 | | | | 116 |
| PENDER HARBOUR CREEKS | 17,000 | Wild | 44 | 2,336 | 7,819 | 7,780 | 3,455 | 5,214 | 5,460 |
| SAKINAW LAKE | 500 | Wild | 39 | 44 | 37 | 243 | 933 | 1,464 | 505 |
| SECHELT CREEK | | Wild | 30 | 94 | 116 | 29 | 80 | 525 | 148 |
| SHANNON CREEK | | Wild | 7 | 33 | 2 | | | | 6 |
| SKWAWKA RIVER | 25,000 | Wild | 44 | 15,831 | 6,320 | 2,305 | 1,418 | 1,111 | 5,219 |
| SLIAMMON CREEK | 14,000 | Wild | 44 | 10,295 | 13,735 | 7,232 | 4,810 | 9,643 | 9,059 |
| SNAKE CREEK | 1,500 | Wild | 45 | 434 | 1,064 | 230 | 763 | 1,200 | 721 |
| STORM CREEK | 2,000 | Wild | 43 | 289 | 1,936 | 264 | 233 | 125 | 611 |
| TSUAHDI CREEK | | Wild | 10 | 294 | 520 | | | | 168 |
| TZOONIE RIVER | 25,000 | Wild | 45 | 23,875 | 20,965 | 12,870 | 14,450 | 13,214 | 17,030 |
| VANCOUVER RIVER | 5,000 | Wild | 45 | 1,816 | 1,403 | 2,085 | 1,438 | 3,786 | 2,006 |
| WEST CREEK | | Wild | 16 | | 231 | 440 | | | 149 |
| WHITTAL CREEK | | Wild | 40 | 1,471 | 3,225 | 1,362 | 425 | 236 | 1,412 |
| TOTAL | 140,100 | | | 108,662 | 95,932 | 73,445 | 56,783 | 63,739 | 79,490 |
| SYSTEMS SURVEYED | | | 36 | 21 | 27 | 25 | 23 | 22 | 24 |

Table 4.1. Continued

| | | | | AVERAGE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REGION/SYSTEM | TARGET | | N | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **LOWER VANCOUVER ISLAND** | | | | | | | | | |
| BECK CREEK | 1,000 | Wild | 6 | 1 | 1 | 7 | | | 2 |
| BLOODS CREEK | 1,000 | Wild | 3 | | 1 | | 3 | 11 | 2 |
| BONELL CREEK | 10,000 | Wild | 43 | 44 | 4,143 | 2,867 | 2,200 | 5,679 | 2,938 |
| BONSALL CREEK | 3,000 | Wild | 43 | 103 | 505 | 800 | 208 | 836 | 484 |
| BUSH CREEK | 10,000 | Wild | 44 | 417 | 3,114 | 2,442 | 2,273 | 4,979 | 2,588 |
| CHASE RIVER | 1,500 | Wild | 21 | 150 | 227 | 61 | | | 91 |
| DEPARTURE CREEK | 1,500 | Wild | 9 | 2 | 9 | 0 | 0 | 0 | 2 |
| HASLAM CREEK | 2,500 | Wild | 15 | 3,654 | 3,245 | | | | 1,371 |
| HOLLAND CREEK | 10,000 | Wild | 45 | 739 | 3,894 | 2,911 | 4,647 | 8,857 | 4,054 |
| KNARSTON CREEK | 1,000 | Wild | 8 | 1 | 4 | 0 | 5 | | 2 |
| MILLSTONE RIVER | 1,000 | Wild | 9 | 47 | 20 | | | | 13 |
| NANAIMO RIVER | 65,000 | Wild | 45 | 54,375 | 44,140 | 35,130 | 20,100 | 39,643 | 37,916 |
| NANOOSE CREEK | 15,000 | Wild | 45 | 268 | 2,842 | 6,030 | 1,003 | 1,854 | 2,531 |
| NAPOLEON CREEK | | Wild | 4 | 1,063 | | | | | 189 |
| PORTERS CREEK | 1,000 | Wild | 15 | | | 1 | 14 | 54 | 12 |
| ROCKEY CREEK | 1,000 | Wild | 27 | 7 | 1 | 10 | 51 | 104 | 31 |
| STOCKING CREEK | 8,000 | Wild | 44 | 441 | 2,888 | 3,020 | 1,722 | 4,071 | 2,407 |
| WALKERS CREEK | 1,500 | Wild | 42 | 22 | 514 | 481 | 320 | 1,593 | 544 |
| TOTAL | 134,000 | | | 61,333 | 65,547 | 53,758 | 32,544 | 67,679 | 55,176 |
| SYSTEMS SURVEYED | | | 18 | 11 | 11 | 10 | 10 | 10 | 10 |

| | | | | AVERAGE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REGION/SYSTEM | TARGET | | N | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **SOUTH VANCOUVER ISLAND** | | | | | | | | | |
| CHEMAINUS RIVER | 50,000 | Wild | 45 | 12,406 | 23,670 | 13,175 | 9,200 | 23,714 | 16,127 |
| COLQUITZ RIVER | 3,000 | Wild | 3 | | 1 | 1 | | | 0 |
| COWICHAN RIVER | 110,000 | Wild | 45 | 103,750 | 108,000 | 63,050 | 55,500 | 51,429 | 76,789 |
| CRAIGFLOWER CREEK | | Wild | 1 | 0 | | | | | 0 |
| FULFORD CREEK | 3,000 | Wild | 4 | 6 | | 10 | 3 | | 4 |
| GOLDSTREAM RIVER | 15,000 | Wild | 45 | 30,894 | 27,850 | 7,850 | 6,950 | 6,857 | 16,037 |
| KOKSILAH RIVER | 20,000 | Wild | 41 | 2,875 | 4,900 | 4,350 | 5,250 | 2,286 | 4,089 |
| SANDHILL CREEK | 10,000 | Wild | 3 | 18 | | | | | 3 |
| SHAWNIGAN CREEK | 3,000 | Wild | 9 | 7 | 0 | 8 | 70 | | 19 |
| TOTAL | 214,000 | | | 149,957 | 164,421 | 88,443 | 76,973 | 84,286 | 113,067 |
| SYSTEMS SURVEYED | | | 9 | 5 | 4 | 4 | 5 | 4 | 4 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **HOWE SOUND/SUNSHINE COAST** | | | | | | | | | |
| ASHLU CREEK | | Wild | 38 | 372 | 503 | 2,293 | 400 | 375 | 835 |
| AVALON CREEK | | Wild | 7 | 13 | | 63 | | | 16 |
| B.C. RAIL SPAWNING CHANNEL | | Wild | 10 | 866 | 540 | | | | 274 |
| BRANCH 100 CREEK | | Wild | 1 | 1 | | | | | 0 |
| BRENNAN CHANNEL | | Wild | 8 | 731 | 50 | | | | 141 |
| BROHM RIVER | | Wild | 1 | | | 3 | | | 1 |
| CENTRE CREEK | | Wild | 1 | 0 | | | | | 0 |
| CHAPMAN CREEK | 4,000 | Wild | 32 | 1,806 | 445 | 1,840 | 45 | | 839 |
| CHASTER CREEK | | Wild | 25 | 50 | 169 | 90 | | | 66 |
| CHEAKAMUS RIVER | 100,000 | Wild | 43 | 37,400 | 53,200 | 33,950 | 19,280 | 23,500 | 33,956 |
| CHUK-CHUK CREEK | | Wild | 6 | 2 | 17 | 3 | | | 5 |
| DAKOTA CREEK | | Wild | 11 | 5 | 41 | 10 | | | 12 |
| DRYDEN CREEK | | Wild | 9 | 468 | 80 | | | | 101 |
| EAGLE CREEK | | Wild | 9 | 0 | 2 | 10 | | | 3 |
| FLUME CREEK | | Wild | 8 | 2 | 3 | 13 | | | 4 |
| HOP RANCH CREEK | | Wild | 5 | 1 | 14 | | | | 3 |
| JUDD SLOUGH | | Wild | 12 | 2,088 | 2,600 | | | | 949 |
| JULY CREEK | | Wild | 2 | 875 | | | | | 156 |
| LANGDALE CREEK | | Wild | 20 | 3 | 10 | 73 | | | 19 |
| LONG BAY CREEK | | Wild | 32 | 750 | 1,720 | 1,835 | 480 | | 1,030 |
| LOWER PARADISE CHANNEL | | Wild | 10 | 2,238 | 1,700 | | | | 776 |
| MAMQUAM RIVER | 40,000 | Wild | 42 | 6,456 | 9,200 | 19,665 | 2,780 | 3,107 | 8,663 |
| MAMQUAM SPAWNING CHANNEL | | Wild | 12 | 2,040 | 1,630 | | | | 725 |
| MANNION CREEK | | Wild | 25 | 39 | 288 | 292 | 50 | | 147 |
| MASHITER CREEK | | Wild | 6 | 18 | 25 | 3 | | | 9 |
| MASHITER SPAWNING CHANNEL | | Wild | 9 | 709 | 288 | | | | 190 |
| MCNAB CREEK | 10,000 | Wild | 35 | 98 | 738 | 525 | 150 | 104 | 347 |
| MCNAIR CREEK | | Wild | 10 | 2 | 13 | 9 | | | 5 |
| MEIGHAN CREEK | | Wild | 9 | 41 | 23 | | | | 12 |
| MISSION CREEK | | Wild | 2 | 475 | | | | | 84 |
| MOODY CHANNEL | | Wild | 9 | 2,171 | 80 | | | | 404 |
| NELSON CREEK | | Wild | 16 | | 2 | 29 | | 179 | 35 |
| OUILLET CREEK | | Wild | 30 | 61 | 360 | 1,224 | 425 | | 457 |
| PILLCHUCK CREEK | | Wild | 30 | 1 | 100 | 238 | 38 | 182 | 112 |
| POTLATCH CREEK | | Wild | 3 | 1 | 8 | 20 | | | 6 |
| RAINY RIVER | | Wild | 14 | 8 | 45 | 14 | | | 15 |
| ROBERTS CREEK | 1,500 | Wild | 32 | 325 | 1,357 | 1,223 | 640 | | 773 |
| SHOVELNOSE CREEK | | Wild | 16 | 122 | 315 | 1,033 | | | 321 |
| SPRING CREEK | | Wild | 6 | 127 | 990 | | | | 243 |
| SQUAMISH RIVER | 200,000 | Wild | 42 | 28,044 | 72,027 | 63,500 | 16,750 | 28,214 | 43,214 |
| STAWAMUS RIVER | | Wild | 28 | 30 | 44 | 5 | 43 | 121 | 44 |
| STAWAMUS SPAWNING CHANNEL | | Wild | 1 | 2 | | | | | 0 |
| TENDERFOOT CREEK | | Wild | 18 | 2,634 | 2,672 | | | | 1,062 |
| TERMINAL CREEK | | Wild | 5 | 10 | 1 | | | | 2 |
| THIRTY SEVEN MILE CREEK | | Wild | 1 | | | 3 | | | 1 |
| THIRTY SIX MILE CREEK | | Wild | 1 | | 3 | | | | 1 |
| TIEMPO SPAWNING CHANNEL | | Wild | 8 | 314 | 8 | | | | 57 |
| TWENTY EIGHT MILE CREEK | | Wild | 7 | 108 | 12 | 3 | | | 22 |
| TWIN CREEK | | Wild | 9 | 4 | 5 | 62 | | | 15 |
| UPPER PARADISE CHANNEL | | Wild | 8 | 3,809 | 1,078 | | | | 917 |
| WAKEFIELD CREEK | | Wild | 21 | 19 | 142 | 455 | | | 136 |
| WEST BAY CREEK | 1,000 | Wild | 31 | 159 | 905 | 1,285 | 175 | | 554 |
| WHISPERING CREEK | | Wild | 5 | 29 | 11 | | | | 8 |
| WILDWOOD SPAWNING CHANNEL | | Wild | 1 | 13 | | | | | 2 |
| WILLIAMSON CREEK | | Wild | 25 | 16 | 120 | 1,142 | 360 | | 363 |
| WILSON CREEK | 1,000 | Wild | 24 | 487 | 319 | 109 | | | 182 |
| TOTAL | 357,500 | | | 96,039 | 153,898 | 131,015 | 41,615 | 55,782 | 98,313 |
| SYSTEMS SURVEYED | | | 56 | 25 | 26 | 22 | 10 | 8 | 18 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **BURRARD INLET** | | | | | | | | | |
| BROTHERS CREEK | 1,000 | Wild | 18 | 60 | 75 | 14 | | | 30 |
| CAPILANO RIVER | | Wild | 42 | 40 | 202 | 457 | 65 | 764 | 287 |
| HASTINGS CREEK | | Wild | 1 | 0 | | | | | 0 |
| INDIAN RIVER | 28,000 | Wild | 45 | 42,350 | 24,950 | 16,350 | 5,850 | 13,571 | 20,118 |
| LYNN CREEK | 1,000 | Wild | 30 | 15 | 9 | 47 | 23 | 61 | 29 |
| MACKAY CREEK | | Wild | 8 | 5 | 1 | 0 | | | 1 |
| MAPLEWOOD CREEK | 1,000 | Wild | 11 | 39 | 5 | | | | 8 |
| MCCARTNEY CREEK | | Wild | 2 | 0 | 1 | | | | 0 |
| MOSQUITO CREEK | | Wild | 1 | 0 | | | | | 0 |
| MOSSOM CREEK | 1,000 | Wild | 12 | 383 | 196 | | | | 112 |
| NOONS CREEK | | Wild | 7 | 29 | | | | | 5 |
| RICHARDS CREEK | | Wild | 1 | 0 | | | | | 0 |
| SEYMOUR RIVER | 1,000 | Wild | 39 | 558 | 1,017 | 150 | 28 | 732 | 478 |
| TOTAL | 33,000 | | | 43,479 | 26,457 | 17,018 | 5,965 | 15,129 | 21,069 |
| SYSTEMS SURVEYED | | | 13 | 7 | 6 | 4 | 4 | 4 | 5 |

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **FRASER RIVER** | | | | | | | | | |
| ALOUETTE RIVER | | Wild | 45 | 15,017 | 18,615 | 7,235 | 1,070 | 1,329 | 8,859 |
| AMERICAN CREEK | | Wild | 8 | 2 | 27 | | 5 | | 7 |
| ANDERSON RIVER | | Wild | 4 | | 29 | | | | 6 |
| ATCHELITZ CREEK | | Wild | 1 | | 2 | | | | 0 |
| BARRETT CREEK | | Wild | 12 | 654 | 37 | 157 | | | 159 |
| BELCHARTON CREEK | | Wild | 27 | 16 | 33 | | 20 | 82 | 27 |
| BIG SILVER CREEK | | Wild | 24 | 16 | 67 | 73 | 50 | 14 | 47 |
| BLANEY CREEK | | Wild | 42 | 874 | 2,356 | 785 | 428 | 318 | 998 |
| BOISE CREEK | | Wild | 1 | 0 | | | | | 0 |
| BORDEN CREEK | | Wild | 4 | 8 | 6 | | | | 3 |
| BOUCHIER CREEK | | Wild | 42 | 241 | 1,051 | 263 | 278 | 396 | 458 |
| BROUSSEAU CREEK | | Wild | 7 | 60 | 160 | 8 | | | 48 |
| BRUNETTE RIVER | | Wild | 10 | 66 | 14 | | | | 15 |
| CAMP SLOUGH | | Wild | 1 | | 1 | | | | 0 |
| CEDAR CREEK | | Wild | 15 | 487 | 976 | | | | 303 |
| CENTER CREEK | | Wild | 1 | | 9 | | | | 2 |
| CHEHALIS RIVER | | Wild | 44 | 62,338 | 53,955 | 41,040 | 24,916 | 20,643 | 40,940 |
| CHILLIWACK CREEK | | Wild | 4 | | 25 | | | | 6 |
| CHILLIWACK RIVER | | Wild | 45 | 195,428 | 153,812 | 69,215 | 66,220 | 12,414 | 100,951 |
| CHILQUA CREEK | | Wild | 41 | 679 | 3,930 | 628 | 140 | 21 | 1,168 |
| CLAYBURN CREEK | | Wild | 14 | 25 | 18 | 3 | 13 | 14 | 14 |
| COGBURN CREEK | | Wild | 11 | | 8 | 5 | 13 | 11 | 7 |
| COHO CREEK | | Wild | 11 | 67 | 116 | | | | 38 |
| COQUIHALLA RIVER | | Wild | 36 | 158 | 315 | 144 | 58 | 79 | 155 |
| COQUITLAM RIVER | | Wild | 44 | 738 | 923 | 1,149 | 63 | 1,150 | 784 |
| DEPOT CREEK | | Wild | 2 | | 7 | | | | 2 |
| DEROCHE CREEK | | Wild | 2 | 4 | | | | | 1 |
| DOUGLAS CREEK | | Wild | 11 | | 12 | 15 | 3 | | 7 |
| DRAPER CREEK | | Wild | 17 | 42 | 130 | 5 | | | 37 |
| EAST CREEK | | Wild | 3 | | 130 | | | | 29 |
| ELK CREEK | | Wild | 1 | | 8 | | | | 2 |
| EMORY CREEK | | Wild | 1 | | 5 | | | | 1 |
| FIFTEEN MILE CREEK | | Wild | 2 | 44 | 50 | | | | 19 |
| FLOODS CREEK | | Wild | 2 | | 65 | | | | 14 |
| FOLEY CREEK | | Wild | 10 | 2 | 50 | 5 | | | 12 |
| FOLEY CREEK SIDE CHANNEL | | Wild | 5 | 127 | 63 | | | | 36 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|
| **FRASER RIVER (CONT.)** | | | | | | | | |
| FOURTEEN MILE CREEK | Wild | 1 | 0 | | | | | 0 |
| GIESBRECHT SPAWNING CHANNEL | Wild | 2 | | 22 | | | | 5 |
| GREYELL SLOUGH | Wild | 1 | | 90 | | | | 20 |
| HARRISON RIVER | Wild | 44 | 422,620 | 123,715 | 108,255 | 87,032 | 41,429 | 152,466 |
| HAWKINS CREEK | Wild | 16 | | | 5 | 95 | 21 | 26 |
| HICKS CREEK | Wild | 37 | 139 | 177 | 50 | 25 | 18 | 84 |
| HOPE SLOUGH | Wild | 2 | | 3 | | | | 1 |
| HOPEDALE SLOUGH | Wild | 18 | 2,125 | 1,632 | 195 | | | 784 |
| HOY CREEK | Wild | 18 | 432 | 616 | | | | 214 |
| HUNTER CREEK | Wild | 33 | 62 | 76 | 27 | 13 | 25 | 40 |
| HYDE CREEK | Wild | 18 | 568 | 452 | | | | 201 |
| INCH CREEK | Wild | 45 | 5,984 | 6,086 | 4,215 | 2,080 | 1,393 | 4,032 |
| KANAKA CREEK | Wild | 45 | 5,094 | 1,733 | 940 | 123 | 1,307 | 1,730 |
| KATZ | Wild | 1 | | 60 | | | | 13 |
| KAWKAWA CREEK | Wild | 43 | 244 | 553 | 219 | 25 | 46 | 227 |
| KAWKAWA LAKE | Wild | 2 | | 85 | | | | 19 |
| KELLY CREEK | Wild | 2 | | 14 | | | | 3 |
| KENWORTHY CREEK | Wild | 7 | 33 | 7 | | | | 7 |
| KOPP CREEK | Wild | 2 | | 10 | | | | 2 |
| LAGACE CREEK | Wild | 26 | 240 | 150 | 118 | 5 | 32 | 108 |
| LILLOOET RIVER | Wild | 10 | 3,563 | 9,200 | | | | 2,678 |
| LIUMCHEN CREEK | Wild | 1 | | 1 | | | | 0 |
| LONZO CREEK | Wild | 7 | | 10 | 23 | | | 7 |
| LORENZETTA CREEK | Wild | 33 | 89 | 36 | 27 | 25 | 21 | 39 |
| LUCKAKUCK CREEK | Wild | 27 | 3 | 8 | 10 | 45 | 69 | 25 |
| MACINTYRE CREEK | Wild | 44 | 255 | 291 | 212 | 158 | 193 | 222 |
| MAHOOD CREEK | Wild | 30 | 286 | 279 | 105 | 23 | 68 | 152 |
| MARIA SLOUGH | Wild | 41 | 55 | 534 | 445 | 453 | 218 | 362 |
| MENZ CREEK | Wild | 2 | 1 | 5 | | | | 1 |
| MOUNTAIN SLOUGH | Wild | 5 | 5 | 3 | 3 | | | 2 |
| MYSTERY CREEK | Wild | 20 | 56 | 3 | 30 | 30 | | 24 |
| NATHAN CREEK | Wild | 14 | 24 | 7 | | 18 | 118 | 28 |
| NESAKWATCH CREEK | Wild | 18 | 369 | 354 | 75 | 145 | | 193 |
| NICOMEN SLOUGH | Wild | 38 | 52 | 4,447 | 3,005 | 1,115 | 1,311 | 2,117 |
| NORRISH CREEK | Wild | 38 | 88 | 2,384 | 3,250 | 848 | 354 | 1,511 |
| NORTH ALOUETTE RIVER | Wild | 43 | 1,053 | 2,765 | 1,313 | 328 | 1,379 | 1,380 |
| OR CREEK | Wild | 1 | | 30 | | | | 7 |
| PEACH CREEK | Wild | 15 | 3,648 | 2,374 | 115 | | | 1,202 |
| PETERS SLOUGH | Wild | 3 | 3 | 116 | | | | 26 |
| PITT RIVER | Wild | 22 | 325 | 539 | 40 | 160 | 546 | 307 |
| POST CREEK | Wild | 1 | | 10 | | | | 2 |
| PURCELL CREEK | Wild | 2 | | | 3 | 3 | | 1 |
| PYE CREEK | Wild | 2 | | 2 | | | | 0 |
| RAILWAY CREEK | Wild | 5 | 217 | | | | | 39 |
| RANGER CREEK | Wild | 3 | 181 | 32 | | | | 39 |
| RUBY CREEK | Wild | 25 | 6 | 25 | 88 | 18 | | 30 |
| RYDER CREEK | Wild | 24 | 11 | 485 | 284 | 157 | | 208 |
| SAKWI CREEK | Wild | 12 | 19 | 363 | 158 | | | 119 |
| SALMON RIVER | Wild | 2 | 7 | 1 | | | | 1 |
| SALWEIN CREEK | Wild | 32 | 75 | 79 | 32 | 54 | 39 | 56 |
| SCHOOLHOUSE CREEK | Wild | 2 | 9 | 0 | | | | 2 |
| SCOREY CREEK | Wild | 20 | 64 | 293 | | | 18 | 79 |
| SCOTT CREEK | Wild | 14 | 112 | 132 | | | | 49 |
| SETON RIVER | Wild | 3 | | 1 | | | | 0 |
| SEVEN MILE CREEK | Wild | 1 | 1 | | | | | 0 |
| SIDDLE CREEK | Wild | 31 | | 13 | 30 | 43 | 50 | 27 |
| SILVERDALE CREEK | Wild | 43 | 221 | 657 | 440 | 349 | 289 | 406 |
| SILVERHOPE CREEK | Wild | 38 | 87 | 338 | 222 | 138 | 157 | 195 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **FRASER RIVER (CONT.)** | | | | | | | | | |
| SLESSE CREEK | | Wild | 15 | 37 | 156 | 14 | 3 | | 45 |
| SLOQUET CREEK | | Wild | 2 | | 40 | | | 57 | 18 |
| SPUZZUM CREEK | | Wild | 4 | | 18 | | | | 4 |
| SQUAWKUM CREEK | | Wild | 42 | 3,807 | 10,336 | 10,630 | 9,681 | 2,614 | 7,894 |
| SQUEAH LAKE CREEK | | Wild | 1 | | 10 | | | | 2 |
| STAVE RIVER | | Wild | 45 | 265,795 | 53,392 | 49,390 | 45,268 | 2,571 | 80,552 |
| STEELHEAD CREEK | | Wild | 14 | 364 | 718 | 190 | | | 267 |
| STEVEN CREEK | | Wild | 2 | | 13 | | | | 3 |
| STREET CREEK | | Wild | 21 | 333 | 430 | 215 | 28 | | 209 |
| SUMAS RIVER | | Wild | 24 | | 217 | 230 | 30 | 39 | 112 |
| SWELTZER RIVER | | Wild | 35 | | 8,312 | 5,100 | 3,900 | 4,179 | 4,497 |
| TAMIHI CREEK | | Wild | 2 | 7 | 3 | | | | 2 |
| TEXAS CREEK | | Wild | 1 | | 2 | | | | 1 |
| THURSTON CREEK | | Wild | 4 | 39 | 131 | | | | 36 |
| TIPELLA CREEK | | Wild | 3 | | | | 3 | 57 | 9 |
| TROUT LAKE CREEK | | Wild | 22 | 328 | 499 | 25 | 18 | 4 | 179 |
| TWENTY MILE CREEK | | Wild | 19 | 70 | 35 | 35 | 88 | | 47 |
| WADES CREEK | | Wild | 6 | 116 | 3 | | | | 21 |
| WAHLEACH CREEK | | Wild | 38 | 149 | 433 | 162 | 131 | 107 | 204 |
| WAHLEACH SLOUGH | | Wild | 13 | 183 | 5,356 | 360 | | | 1,303 |
| WEAVER CREEK | | Wild | 43 | 4,689 | 35,575 | 22,570 | 2,940 | 1,075 | 14,575 |
| WEST CREEK | | Wild | 38 | 278 | 35 | 198 | 163 | 846 | 269 |
| WHONNOCK CREEK | | Wild | 42 | 849 | 1,348 | 1,065 | 708 | 786 | 966 |
| WIDGEON CREEK | | Wild | 42 | 512 | 1,327 | 875 | 348 | 811 | 783 |
| WORTH CREEK | | Wild | 38 | 340 | 1,487 | 413 | 125 | 393 | 571 |
| YALE CREEK | | Wild | 1 | | 10 | | | | 2 |
| YORKSON CREEK | | Wild | 1 | | | | | 4 | 1 |
| TOTAL | 700,000 | | | 1,003,409 | 518,178 | 336,126 | 250,204 | 99,115 | 439,248 |
| SYSTEMS SURVEYED | | | 121 | 41 | 62 | 45 | 42 | 41 | 47 |

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **BOUNDARY BAY** | | | | | | | | | |
| CAMPBELL RIVER | 5,000 | Wild | 39 | 121 | 286 | 208 | 40 | 296 | 186 |
| MURRAY CREEK | | Wild | 1 | 6 | | | | | 1 |
| NICOMEKL RIVER | | Wild | 2 | 81 | | | | | 14 |
| SERPENTINE RIVER | | Wild | 7 | 738 | 5 | | | | 132 |
| TOTAL | 5,000 | | | 946 | 291 | 208 | 40 | 296 | 334 |
| SYSTEMS SURVEYED | | | 4 | 2 | 1 | 1 | 1 | 1 | 1 |

Table 4.1. Continued

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **SUMMER CHUM** | | | | | | | | | |
| AHNUHATI RIVER | 50,000 | Wild | 44 | 3960 | 11020 | 3530 | 6000 | 15571 | 7,693 |
| ORFORD RIVER | 80,000 | Wild | 44 | 22063 | 42050 | 50625 | 7150 | 10357 | 27,717 |
| TOTAL | 130,000 | | | 26023 | 53070 | 54155 | 13150 | 25929 | 35,410 |
| SYSTEMS SERVEYED | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| REGION/SYSTEM | TARGET | | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| **ENHANCED** | | | | | | | | | |
| QUATSE RIVER | | Enhanced | 8 | 36 | 43 | | | | 16 |
| KINGCOME RIVER | | Enhanced | 1 | | 4 | | | | 1 |
| GLENDALE CREEK | | Enhanced | 3 | 1,450 | 820 | | | | 440 |
| NIMPKISH RIVER | | Enhanced | 9 | 695 | 380 | | | | 208 |
| ORFORD RIVER | | Enhanced | 2 | 250 | | | | | 44 |
| PHILLIPS RIVER | | Enhanced | 6 | 150 | 990 | | | | 247 |
| LITTLE QUALICUM RIVER | 30,000 | Enhanced | 16 | 42,582 | 34,738 | | | | 15,290 |
| PUNTLEDGE RIVER | 5,000 | Enhanced | 14 | 5,310 | 4,133 | | | | 1,862 |
| QUALICUM RIVER | 100,000 | Enhanced | 40 | 90,590 | 102,890 | 113,250 | 55,535 | 13,750 | 78,922 |
| MID VAN IS | | Rack | 18 | 276 | 10,831 | 528 | | | 2,573 |
| LANG CREEK | | Enhanced | 1 | | 10 | | | | 2 |
| SLIAMMON CREEK | | Enhanced | 6 | 75 | 3,200 | | | | 724 |
| CHEMAINUS RIVER | | Enhanced | 3 | 1,250 | 1,890 | | | | 642 |
| MCNAB CREEK | | Enhanced | 1 | | 11 | | | | 2 |
| CHEHALIS RIVER | | Enhanced | 14 | 9,368 | 10,128 | | | | 3,916 |
| CHILLIWACK RIVER | | Enhanced | 13 | 3,803 | 2,556 | | | | 1,244 |
| INCH CREEK | | Enhanced | 14 | 1,184 | 4,782 | | | | 1,273 |
| STAVE RIVER | | Enhanced | 13 | 4,356 | 2,552 | | | | 1,342 |
| FRASER RIVER | | Rack | 13 | 92,677 | 43,416 | | | | 26,124 |
| CAMPBELL RIVER | | Enhanced | 29 | 13 | 290 | 220 | 40 | 238 | 167 |
| TOTAL | | | | 254,065 | 223,663 | 113,998 | 55,575 | 13,988 | 135,040 |
| SYSTEMS ENHANCED | | | 18 | 10 | 10 | 2 | 1 | 1 | 5 |

| | TARGET | SOURCE | N | AVERAGE 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
|---|---|---|---|---|---|---|---|---|---|
| ISA TOTAL WILD[1] | 3,235,100 | Wild | | 1,793,597 | 1,412,080 | 1,061,717 | 752,740 | 856,908 | 1,169,167 |
| ISA TOTAL WILD SERVEYED | | | 402 | 173 | 207 | 190 | 186 | 201 | 191 |
| ISA TOTAL ENHANCED[1] | | Enhanced | | 254,065 | 223,663 | 113,998 | 55,575 | 13,988 | 135,040 |
| ISA ENHANCED SURVEYED | | | 18 | 10 | 10 | 2 | 1 | 1 | 5 |
| ISA TOTAL ESCAPEMENT[1] | | W&E | | 2,047,662 | 1,635,743 | 1,175,715 | 808,315 | 870,895 | 1,304,206 |
| ISA TOTAL SURVEYED | | | 402 | 173 | 207 | 190 | 186 | 201 | 191 |
| SUMMER TOTAL | 130,000 | Wild | | 26023 | 53070 | 54155 | 13150 | 25929 | 35,410 |
| SYSTEMS SERVEYED | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| ISC TOTAL WILD[2] | 3,400,100 | Wild | | 1,806,829 | 1,432,165 | 1,091,302 | 772,000 | 883,751 | 1,191,012 |
| ISC TOTAL SYSTEMS SURVEYED | | | 421 | 183 | 218 | 201 | 196 | 214 | 202 |

Note 1 Excludes Summer and Seymour/Belize chum stocks

Note 2 Includes Seymour/Belize; excludes Summer chum stocks

Table 4.2. Rank for the top 50 Inner South Coast chum salmon systems within each time period. Rank based on average total escapement for each system during each time period. Contribution of each stock to the total average escapement during the time period represented by percent and cumulative percent.

| SYSTEM | AVERAGE ESCAPEMENT | PERCENT | CUMULATIVE PERCENT |
|---|---|---|---|
| 1990-1997 | | | |
| HARRISON RIVER | 422,620 | 22.06 | 22.06 |
| STAVE RIVER | 265,795 | 13.88 | 35.94 |
| CHILLIWACK RIVER | 195,428 | 10.20 | 46.14 |
| COWICHAN RIVER | 103,750 | 5.42 | 51.56 |
| QUALICUM RIVER | 90,590 | 4.73 | 56.29 |
| LITTLE QUALICUM RIVER | 72,563 | 3.79 | 60.07 |
| NIMPKISH RIVER | 67,459 | 3.52 | 63.60 |
| SOUTHGATE RIVER | 66,875 | 3.49 | 67.09 |
| CHEHALIS RIVER | 62,338 | 3.25 | 70.34 |
| PUNTLEDGE RIVER | 62,149 | 3.24 | 73.59 |
| NANAIMO RIVER | 54,375 | 2.84 | 76.43 |
| INDIAN RIVER | 42,350 | 2.21 | 78.64 |
| CHEAKAMUS RIVER | 37,400 | 1.95 | 80.59 |
| DESERTED RIVER | 35,250 | 1.84 | 82.43 |
| GOLDSTREAM RIVER | 30,894 | 1.61 | 84.04 |
| SQUAMISH RIVER | 28,044 | 1.46 | 85.51 |
| TZOONIE RIVER | 23,875 | 1.25 | 86.75 |
| ORFORD RIVER | 22,063 | 1.15 | 87.90 |
| SKWAWKA RIVER | 15,831 | 0.83 | 88.73 |
| ALOUETTE RIVER | 15,017 | 0.78 | 89.51 |
| CHEMAINUS RIVER | 12,406 | 0.65 | 90.16 |
| LANG CREEK | 11,276 | 0.59 | 90.75 |
| SLIAMMON CREEK | 10,295 | 0.54 | 91.29 |
| HOMATHKO RIVER | 9,750 | 0.51 | 91.80 |
| STAFFORD RIVER | 6,888 | 0.36 | 92.16 |
| MAMQUAM RIVER | 6,456 | 0.34 | 92.49 |
| CAMPBELL RIVER | 6,313 | 0.33 | 92.82 |
| INCH CREEK | 5,984 | 0.31 | 93.14 |
| KANAKA CREEK | 5,094 | 0.27 | 93.40 |
| WEAVER CREEK | 4,689 | 0.24 | 93.65 |
| VINER SOUND CREEK | 4,138 | 0.22 | 93.86 |
| AHNUHATI RIVER | 3,960 | 0.21 | 94.07 |
| UPPER PARADISE CHANNEL | 3,809 | 0.20 | 94.27 |
| SQUAWKUM CREEK | 3,807 | 0.20 | 94.47 |
| HASLAM CREEK | 3,654 | 0.19 | 94.66 |
| PEACH CREEK | 3,648 | 0.19 | 94.85 |
| LILLOOET RIVER | 3,563 | 0.19 | 95.03 |
| HEYDON CREEK | 3,500 | 0.18 | 95.22 |
| GLENDALE CREEK | 3,352 | 0.17 | 95.39 |
| KOKSILAH RIVER | 2,875 | 0.15 | 95.54 |
| ENGLISHMAN RIVER | 2,756 | 0.14 | 95.69 |
| FULMORE RIVER | 2,675 | 0.14 | 95.83 |
| TENDERFOOT CREEK | 2,634 | 0.14 | 95.96 |
| PENDER HARBOUR CREEKS | 2,336 | 0.12 | 96.08 |
| LOWER PARADISE CHANNEL | 2,238 | 0.12 | 96.20 |
| MOODY CHANNEL | 2,171 | 0.11 | 96.31 |
| HOPEDALE SLOUGH | 2,125 | 0.11 | 96.43 |
| JUDD SLOUGH | 2,088 | 0.11 | 96.53 |
| MORRISON CREEK | 2,075 | 0.11 | 96.64 |
| MAMQUAM SPAWNING CHANNEL | 2,040 | 0.11 | 96.75 |

Table 4.2. Continued

| SYSTEM | AVERAGE ESCAPEMENT | PERCENT | CUMULATIVE PERCENT |
|---|---|---|---|
| 1980-1989 | | | |
| CHILLIWACK RIVER | 153,812 | 9.78 | 9.78 |
| HARRISON RIVER | 123,715 | 7.87 | 17.65 |
| COWICHAN RIVER | 108,000 | 6.87 | 24.52 |
| SOUTHGATE RIVER | 106,700 | 6.79 | 31.31 |
| QUALICUM RIVER | 102,890 | 6.54 | 37.85 |
| SQUAMISH RIVER | 72,027 | 4.58 | 42.43 |
| PUNTLEDGE RIVER | 64,109 | 4.08 | 46.51 |
| LITTLE QUALICUM RIVER | 54,472 | 3.46 | 49.98 |
| CHEHALIS RIVER | 53,955 | 3.43 | 53.41 |
| STAVE RIVER | 53,392 | 3.40 | 56.80 |
| CHEAKAMUS RIVER | 53,200 | 3.38 | 60.19 |
| NANAIMO RIVER | 44,140 | 2.81 | 63.00 |
| NIMPKISH RIVER | 42,365 | 2.69 | 65.69 |
| ORFORD RIVER | 42,050 | 2.67 | 68.37 |
| WEAVER CREEK | 35,575 | 2.26 | 70.63 |
| GOLDSTREAM RIVER | 27,850 | 1.77 | 72.40 |
| VINER SOUND CREEK | 25,420 | 1.62 | 74.02 |
| INDIAN RIVER | 24,950 | 1.59 | 75.60 |
| CHEMAINUS RIVER | 23,670 | 1.51 | 77.11 |
| TZOONIE RIVER | 20,965 | 1.33 | 78.44 |
| DESERTED RIVER | 20,050 | 1.28 | 79.72 |
| ALOUETTE RIVER | 18,615 | 1.18 | 80.90 |
| HOMATHKO RIVER | 14,425 | 0.92 | 81.82 |
| SLIAMMON CREEK | 13,735 | 0.87 | 82.69 |
| HEYDON CREEK | 13,570 | 0.86 | 83.56 |
| AHNUHATI RIVER | 11,020 | 0.70 | 84.26 |
| SQUAWKUM CREEK | 10,336 | 0.66 | 84.91 |
| MAMQUAM RIVER | 9,200 | 0.59 | 85.50 |
| LILLOOET RIVER | 9,200 | 0.59 | 86.09 |
| SWELTZER RIVER | 8,312 | 0.53 | 86.61 |
| PENDER HARBOUR CREEKS | 7,819 | 0.50 | 87.11 |
| BISHOP CREEK | 7,373 | 0.47 | 87.58 |
| SKWAWKA RIVER | 6,320 | 0.40 | 87.98 |
| INCH CREEK | 6,086 | 0.39 | 88.37 |
| WAHLEACH SLOUGH | 5,356 | 0.34 | 88.71 |
| KOKSILAH RIVER | 4,900 | 0.31 | 89.02 |
| NICOMEN SLOUGH | 4,447 | 0.28 | 89.30 |
| BONELL CREEK | 4,143 | 0.26 | 89.57 |
| OKEOVER CREEK | 3,941 | 0.25 | 89.82 |
| CHILQUA CREEK | 3,930 | 0.25 | 90.07 |
| HOLLAND CREEK | 3,894 | 0.25 | 90.32 |
| CAMPBELL RIVER | 3,555 | 0.23 | 90.54 |
| AHTA RIVER | 3,498 | 0.22 | 90.76 |
| CHEF CREEK | 3,265 | 0.21 | 90.97 |
| APPLE RIVER | 3,260 | 0.21 | 91.18 |
| HASLAM CREEK | 3,245 | 0.21 | 91.39 |
| WHITTAL CREEK | 3,225 | 0.21 | 91.59 |
| BUSH CREEK | 3,114 | 0.20 | 91.79 |
| TSOLUM RIVER | 3,008 | 0.19 | 91.98 |
| STOCKING CREEK | 2,888 | 0.18 | 92.16 |

Table 4.2. Continued

| SYSTEM | AVERAGE ESCAPEMENT | PERCENT | CUMULATIVE PERCENT |
|---|---|---|---|
| 1970-1979 | | | |
| QUALICUM RIVER | 113,250 | 9.21 | 9.21 |
| HARRISON RIVER | 108,255 | 8.81 | 18.02 |
| CHILLIWACK RIVER | 69,215 | 5.63 | 23.65 |
| SQUAMISH RIVER | 63,500 | 5.17 | 28.82 |
| COWICHAN RIVER | 63,050 | 5.13 | 33.95 |
| LITTLE QUALICUM RIVER | 53,250 | 4.33 | 38.28 |
| ORFORD RIVER | 50,625 | 4.12 | 42.40 |
| STAVE RIVER | 49,390 | 4.02 | 46.42 |
| CHEHALIS RIVER | 41,040 | 3.34 | 49.76 |
| PUNTLEDGE RIVER | 40,600 | 3.30 | 53.06 |
| SOUTHGATE RIVER | 36,200 | 2.95 | 56.01 |
| NANAIMO RIVER | 35,130 | 2.86 | 58.86 |
| CHEAKAMUS RIVER | 33,950 | 2.76 | 61.63 |
| VINER SOUND CREEK | 27,500 | 2.24 | 63.86 |
| WEAVER CREEK | 22,570 | 1.84 | 65.70 |
| KINGCOME RIVER | 22,270 | 1.81 | 67.51 |
| HOMATHKO RIVER | 20,100 | 1.64 | 69.15 |
| MAMQUAM RIVER | 19,665 | 1.60 | 70.75 |
| HEYDON CREEK | 18,825 | 1.53 | 72.28 |
| DESERTED RIVER | 18,450 | 1.50 | 73.78 |
| INDIAN RIVER | 16,350 | 1.33 | 75.11 |
| CHEMAINUS RIVER | 13,175 | 1.07 | 76.18 |
| TZOONIE RIVER | 12,870 | 1.05 | 77.23 |
| NIMPKISH RIVER | 12,700 | 1.03 | 78.26 |
| BISHOP CREEK | 11,936 | 0.97 | 79.23 |
| AHTA RIVER | 11,520 | 0.94 | 80.17 |
| KLINAKLINI RIVER | 11,500 | 0.94 | 81.11 |
| SQUAWKUM CREEK | 10,630 | 0.86 | 81.97 |
| GLENDALE CREEK | 9,730 | 0.79 | 82.76 |
| GOLDSTREAM RIVER | 7,850 | 0.64 | 83.40 |
| PENDER HARBOUR CREEKS | 7,780 | 0.63 | 84.03 |
| APPLE RIVER | 7,300 | 0.59 | 84.63 |
| ALOUETTE RIVER | 7,235 | 0.59 | 85.22 |
| SLIAMMON CREEK | 7,232 | 0.59 | 85.80 |
| MACKENZIE SOUND CREEK | 6,610 | 0.54 | 86.34 |
| NANOOSE CREEK | 6,030 | 0.49 | 86.83 |
| SWELTZER RIVER | 5,100 | 0.41 | 87.25 |
| WAKEMAN RIVER | 5,055 | 0.41 | 87.66 |
| TSABLE RIVER | 4,970 | 0.40 | 88.06 |
| ENGLISHMAN RIVER | 4,825 | 0.39 | 88.46 |
| CAMPBELL RIVER | 4,820 | 0.39 | 88.85 |
| KOKSILAH RIVER | 4,350 | 0.35 | 89.20 |
| TOBA RIVER | 4,350 | 0.35 | 89.56 |
| PHILLIPS RIVER | 4,275 | 0.35 | 89.90 |
| INCH CREEK | 4,215 | 0.34 | 90.25 |
| KAKWEIKEN RIVER | 4,120 | 0.34 | 90.58 |
| CHEF CREEK | 4,065 | 0.33 | 90.91 |
| THEODOSIA RIVER | 3,755 | 0.31 | 91.22 |
| AHNUHATI RIVER | 3,530 | 0.29 | 91.51 |
| NORRISH CREEK | 3,250 | 0.26 | 91.77 |

Table 4.2. Continued

| SYSTEM | AVERAGE ESCAPEMENT | PERCENT | CUMULATIVE PERCENT |
|---|---|---|---|
| 1960-1969 | | | |
| HARRISON RIVER | 87,032 | 10.60 | 10.60 |
| CHILLIWACK RIVER | 66,220 | 8.06 | 18.66 |
| QUALICUM RIVER | 55,535 | 6.76 | 25.42 |
| COWICHAN RIVER | 55,500 | 6.76 | 32.17 |
| STAVE RIVER | 45,268 | 5.51 | 37.69 |
| LITTLE QUALICUM RIVER | 42,500 | 5.17 | 42.86 |
| PUNTLEDGE RIVER | 33,400 | 4.07 | 46.93 |
| VINER SOUND CREEK | 30,640 | 3.73 | 50.66 |
| CHEHALIS RIVER | 24,916 | 3.03 | 53.69 |
| NIMPKISH RIVER | 24,250 | 2.95 | 56.64 |
| NANAIMO RIVER | 20,100 | 2.45 | 59.09 |
| CHEAKAMUS RIVER | 19,280 | 2.35 | 61.43 |
| GLENDALE CREEK | 18,858 | 2.30 | 63.73 |
| SQUAMISH RIVER | 16,750 | 2.04 | 65.77 |
| TZOONIE RIVER | 14,450 | 1.76 | 67.53 |
| BISHOP CREEK | 12,550 | 1.53 | 69.06 |
| KINGCOME RIVER | 11,200 | 1.36 | 70.42 |
| HEYDON CREEK | 10,475 | 1.28 | 71.70 |
| AHTA RIVER | 9,820 | 1.20 | 72.89 |
| SQUAWKUM CREEK | 9,681 | 1.18 | 74.07 |
| KLINAKLINI RIVER | 9,408 | 1.15 | 75.21 |
| CHEMAINUS RIVER | 9,200 | 1.12 | 76.33 |
| TOBA RIVER | 7,250 | 0.88 | 77.22 |
| ORFORD RIVER | 7,150 | 0.87 | 78.09 |
| GOLDSTREAM RIVER | 6,950 | 0.85 | 78.93 |
| SOUTHGATE RIVER | 6,650 | 0.81 | 79.74 |
| TSABLE RIVER | 6,525 | 0.79 | 80.54 |
| DESERTED RIVER | 6,100 | 0.74 | 81.28 |
| AHNUHATI RIVER | 6,000 | 0.73 | 82.01 |
| INDIAN RIVER | 5,850 | 0.71 | 82.72 |
| THEODOSIA RIVER | 5,850 | 0.71 | 83.43 |
| KOKSILAH RIVER | 5,250 | 0.64 | 84.07 |
| QUATSE RIVER | 5,065 | 0.62 | 84.69 |
| SLIAMMON CREEK | 4,810 | 0.59 | 85.28 |
| HOLLAND CREEK | 4,647 | 0.57 | 85.84 |
| SWELTZER RIVER | 3,900 | 0.47 | 86.32 |
| ENGLISHMAN RIVER | 3,575 | 0.44 | 86.75 |
| PENDER HARBOUR CREEKS | 3,455 | 0.42 | 87.17 |
| HOMATHKO RIVER | 3,260 | 0.40 | 87.57 |
| KAKWEIKEN RIVER | 3,100 | 0.38 | 87.95 |
| WEAVER CREEK | 2,940 | 0.36 | 88.30 |
| LANG CREEK | 2,815 | 0.34 | 88.65 |
| MAMQUAM RIVER | 2,780 | 0.34 | 88.99 |
| PHILLIPS RIVER | 2,605 | 0.32 | 89.30 |
| ANGUS CREEK | 2,600 | 0.32 | 89.62 |
| LITTLE TOBA RIVER | 2,598 | 0.32 | 89.94 |
| KLITE RIVER | 2,515 | 0.31 | 90.24 |
| WAKEMAN RIVER | 2,450 | 0.30 | 90.54 |
| BUSH CREEK | 2,273 | 0.28 | 90.82 |
| BONELL CREEK | 2,200 | 0.27 | 91.08 |

Table 4.2. Continued

| SYSTEM | AVERAGE ESCAPEMENT | PERCENT | CUMULATIVE PERCENT |
|---|---|---|---|
| 1953-1959 | | | |
| VINER SOUND CREEK | 55,000 | 6.13 | 6.13 |
| COWICHAN RIVER | 51,429 | 5.74 | 11.87 |
| NIMPKISH RIVER | 42,857 | 4.78 | 16.65 |
| HARRISON RIVER | 41,429 | 4.62 | 21.27 |
| NANAIMO RIVER | 39,643 | 4.42 | 25.69 |
| QUALICUM RIVER | 35,893 | 4.00 | 29.70 |
| LITTLE QUALICUM RIVER | 35,000 | 3.90 | 33.60 |
| PUNTLEDGE RIVER | 32,143 | 3.59 | 37.18 |
| SQUAMISH RIVER | 28,214 | 3.15 | 40.33 |
| CHEMAINUS RIVER | 23,714 | 2.64 | 42.98 |
| CHEAKAMUS RIVER | 23,500 | 2.62 | 45.60 |
| TOBA RIVER | 22,500 | 2.51 | 48.11 |
| CHEHALIS RIVER | 20,643 | 2.30 | 50.41 |
| KLINAKLINI RIVER | 17,429 | 1.94 | 52.35 |
| THEODOSIA RIVER | 17,071 | 1.90 | 54.26 |
| HOMATHKO RIVER | 16,029 | 1.79 | 56.05 |
| AHNUHATI RIVER | 15,571 | 1.74 | 57.78 |
| INDIAN RIVER | 13,571 | 1.51 | 59.30 |
| TZOONIE RIVER | 13,214 | 1.47 | 60.77 |
| CHILLIWACK RIVER | 12,414 | 1.38 | 62.15 |
| KINGCOME RIVER | 12,286 | 1.37 | 63.52 |
| AHTA RIVER | 10,929 | 1.22 | 64.74 |
| DESERTED RIVER | 10,786 | 1.20 | 65.95 |
| KAKWEIKEN RIVER | 10,557 | 1.18 | 67.12 |
| ORFORD RIVER | 10,357 | 1.16 | 68.28 |
| QUATSE RIVER | 10,143 | 1.13 | 69.41 |
| SLIAMMON CREEK | 9,643 | 1.08 | 70.49 |
| HOLLAND CREEK | 8,857 | 0.99 | 71.47 |
| ENGLISHMAN RIVER | 8,321 | 0.93 | 72.40 |
| TSABLE RIVER | 8,000 | 0.89 | 73.29 |
| SOUTHGATE RIVER | 7,429 | 0.83 | 74.12 |
| HEYDON CREEK | 7,200 | 0.80 | 74.93 |
| GOLDSTREAM RIVER | 6,857 | 0.76 | 75.69 |
| WAKEMAN RIVER | 6,857 | 0.76 | 76.46 |
| SHOAL HARBOUR CREEK | 6,000 | 0.67 | 77.12 |
| NIMMO CREEK | 5,893 | 0.66 | 77.78 |
| BONELL CREEK | 5,679 | 0.63 | 78.41 |
| OYSTER RIVER | 5,500 | 0.61 | 79.03 |
| BISHOP CREEK | 5,214 | 0.58 | 79.61 |
| PENDER HARBOUR CREEKS | 5,214 | 0.58 | 80.19 |
| MCNAUGHTON CREEK | 5,214 | 0.58 | 80.77 |
| BUSH CREEK | 4,979 | 0.56 | 81.33 |
| GLENDALE CREEK | 4,929 | 0.55 | 81.88 |
| LANG CREEK | 4,714 | 0.53 | 82.40 |
| KEOGH RIVER | 4,279 | 0.48 | 82.88 |
| MACKENZIE SOUND CREEK | 4,250 | 0.47 | 83.36 |
| SWELTZER RIVER | 4,179 | 0.47 | 83.82 |
| STOCKING CREEK | 4,071 | 0.45 | 84.28 |
| SALMON RIVER | 3,964 | 0.44 | 84.72 |
| MARION CREEK | 3,914 | 0.44 | 85.15 |

Table 4.2. Continued

| SYSTEM | AVERAGE ESCAPEMENT | PERCENT | CUMULATIVE PERCENT |
|---|---|---|---|
| 1953-1997 | | | |
| HARRISON RIVER | 152,466 | 11.86 | 11.86 |
| CHILLIWACK RIVER | 100,951 | 7.85 | 19.72 |
| QUALICUM RIVER | 82,366 | 6.41 | 26.12 |
| STAVE RIVER | 80,552 | 6.27 | 32.39 |
| COWICHAN RIVER | 76,789 | 5.97 | 38.36 |
| LITTLE QUALICUM RIVER | 51,727 | 4.02 | 42.39 |
| SOUTHGATE RIVER | 46,278 | 3.60 | 45.99 |
| PUNTLEDGE RIVER | 46,740 | 3.64 | 49.63 |
| SQUAMISH RIVER | 43,214 | 3.36 | 52.99 |
| CHEHALIS RIVER | 40,940 | 3.19 | 56.17 |
| NANAIMO RIVER | 37,916 | 2.95 | 59.12 |
| NIMPKISH RIVER | 36,285 | 2.82 | 61.95 |
| CHEAKAMUS RIVER | 33,956 | 2.64 | 64.59 |
| VINER SOUND CREEK | 27,860 | 2.17 | 66.75 |
| ORFORD RIVER | 27,717 | 2.16 | 68.91 |
| INDIAN RIVER | 20,118 | 1.57 | 70.48 |
| DESERTED RIVER | 17,856 | 1.39 | 71.87 |
| TZOONIE RIVER | 17,030 | 1.32 | 73.19 |
| CHEMAINUS RIVER | 16,127 | 1.25 | 74.44 |
| GOLDSTREAM RIVER | 16,037 | 1.25 | 75.69 |
| WEAVER CREEK | 14,575 | 1.13 | 76.83 |
| HOMATHKO RIVER | 12,623 | 0.98 | 77.81 |
| HEYDON CREEK | 11,269 | 0.88 | 78.69 |
| KINGCOME RIVER | 10,187 | 0.79 | 79.48 |
| SLIAMMON CREEK | 9,059 | 0.70 | 80.18 |
| ALOUETTE RIVER | 8,859 | 0.69 | 80.87 |
| MAMQUAM RIVER | 8,663 | 0.67 | 81.55 |
| BISHOP CREEK | 8,144 | 0.63 | 82.18 |
| GLENDALE CREEK | 8,133 | 0.63 | 82.81 |
| SQUAWKUM CREEK | 7,894 | 0.61 | 83.43 |
| AHNUHATI RIVER | 7,693 | 0.60 | 84.02 |
| KLINAKLINI RIVER | 7,438 | 0.58 | 84.60 |
| AHTA RIVER | 7,436 | 0.58 | 85.18 |
| TOBA RIVER | 6,562 | 0.51 | 85.69 |
| PENDER HARBOUR CREEKS | 5,460 | 0.42 | 86.12 |
| THEODOSIA RIVER | 5,350 | 0.42 | 86.53 |
| SKWAWKA RIVER | 5,219 | 0.41 | 86.94 |
| TSABLE RIVER | 4,649 | 0.36 | 87.30 |
| SWELTZER RIVER | 4,497 | 0.35 | 87.65 |
| LANG CREEK | 4,299 | 0.33 | 87.99 |
| KOKSILAH RIVER | 4,089 | 0.32 | 88.30 |
| HOLLAND CREEK | 4,054 | 0.32 | 88.62 |
| INCH CREEK | 4,032 | 0.31 | 88.93 |
| ENGLISHMAN RIVER | 4,011 | 0.31 | 89.24 |
| KAKWEIKEN RIVER | 3,885 | 0.30 | 89.55 |
| CAMPBELL RIVER | 3,493 | 0.27 | 89.82 |
| WAKEMAN RIVER | 3,298 | 0.26 | 90.08 |
| MACKENZIE SOUND CREEK | 3,246 | 0.25 | 90.33 |
| BONELL CREEK | 2,938 | 0.23 | 90.56 |
| QUATSE RIVER | 2,881 | 0.22 | 90.78 |

Table 4.3. Rank by wild target escapement and average escapement estimates for Inner South Coast Chum Salmon Regions. Ranked by region within each time period. Target is the total target wild escapement for each region.

| | WILD ESCAPEMENT | | RANK BY AVERAGE ESCAPEMENT ESTIMATES | | | | | |
|---|---|---|---|---|---|---|---|---|
| REGION | TARGET | RANK | 1990-1997 | 1980-1989 | 1970-1979 | 1960-1969 | 1953-1959 | 1953-1997 |
| **FRASER RIVER** | 700,000 | 1 | 1 | 1 | 1 | 1 | 4 | 1 |
| **LOUGHBOROUGH/BUTE INLETS** | 437,000 | 2 | 4 | 3 | 3 | 6 | 8 | 4 |
| **HOWE SOUND/SUNSHINE COAST** | 357,500 | 3 | 6 | 5 | 4 | 7 | 9 | 6 |
| **BOND/KNIGHT INLETS** | 346,000 | 4 | 10 | 9 | 7 | 4 | 3 | 7 |
| **MID VANCOUVER ISLAND** | 230,500 | 5 | 2 | 2 | 2 | 2 | 2 | 2 |
| **SOUTH VANCOUVER ISLAND** | 214,000 | 6 | 3 | 4 | 6 | 5 | 5 | 5 |
| **KINGCOME INLET** | 195,500 | 7 | 12 | 12 | 9 | 12 | 11 | 11 |
| **JOHNSTONE STRAIT** | 190,000 | 8 | 7 | 8 | 11 | 8 | 7 | 9 |
| **TOBA INLET** | 172,000 | 9 | 15 | 13 | 13 | 10 | 10 | 13 |
| **SEYMOUR/BELIZE INLETS** | 165,000 | 10 | 11 | 11 | 10 | 11 | 12 | 10 |
| **JERVIS INLET** | 140,100 | 11 | 5 | 6 | 5 | 3 | 1 | 3 |
| **LOWER VANCOUVER ISLAND** | 134,000 | 12 | 8 | 7 | 8 | 9 | 6 | 8 |
| **UPPER VANCOUVER ISLAND** | 67,000 | 13 | 14 | 15 | 14 | 13 | 13 | 14 |
| **BURRARD INLET** | 33,000 | 14 | 9 | 10 | 12 | 14 | 14 | 12 |
| **BOUNDARY BAY** | 5,000 | 15 | 13 | 14 | 15 | 15 | 15 | 15 |

Table 4.4. Comparison of escapement estimates for selected ISC chum systems in 1997. Estimates obtained by standardized index sites and area under the curve (AUC) analysis and traditional escapement surveys (BC 16).

| | Target | Estimates | |
|---|---|---|---|
| | | AUC | BC 16 |
| Seymour/ Belize Inlets | | | |
| Driftwood | 20000 | 59 | 54 |
| Jap | 20000 | 770 | 400 |
| Taaltz | 45000 | 653 | 2900 |
| Waump | 18000 | 335 | 400 |
| Bond/Knight Inlets | | | |
| Ahta | 20000 | 1161 | 2080 |
| Kakweikan | 75000 | 383 | 369 |
| Lull | 100 | 19 | 15 |
| Viner Sound | 40000 | 221 | 97 |
| Loughborough/Bute Inlets | | | |
| Heydon | 35000 | 3752 | 2500 |
| Orford | 80000 | 7432 | 2000 |
| Quatum | 300 | 120 | 70 |
| Wortley | 100 | 383 | 250 |
| Toba Inlet | | | |
| Brem | 15000 | 1035 | 361 |
| Forbes | 15000 | 1035 | 2742 |
| Okeover | 6000 | 5058 | 500 |
| Theodosia | 21000 | 6016 | 2742 |

Table 4.5. Chum salmon target escapements and habitat estimates based on spawning gravel estimates for selected systems in the Inner South Coast. Target escapements for non-Fraser stocks from Inner South Coast Management Plan (1986). UVI, JS, MVI, LVI, and SVI habitat estimates from Fraser et al. (1974), S/B and L/B from HRSEP Project (unpublished results 1997). Fraser River target escapement s and habitat estimates from Palmer (1972). Habitat estimates use 1.0 to 1.5 chum/sq.yd. of spawning gravel (Palmer 1972, Fraser et al. 1974).

| REGION/SYSTEM | TARGET | HABITAT |
|---|---|---|
| **SEYMOUR/BELIZE INLETS** | | |
| DRIFTWOOD CREEK | 20,000 | 4,000 |
| JAP CREEEK | 20,000 | 1,000 |
| RAINBOW CREEK | 5,000 | 8,100 |
| TAALTZ CREEK | 45,000 | 4,600 |
| WAUMP CREEK | 18,000 | 6,400 |
| TOTAL | 88,000 | 20,100 |
| **UPPER VANCOUVER ISLAND** | | |
| CLUXEWE RIVER | 5,000 | 72,800 |
| KEOGH RIVER | 15,000 | 20,400 |
| QUATSE RIVER | 10,000 | 49,000 |
| TSULQUATE RIVER | 5,000 | 200 |
| TOTAL | 35,000 | 142,400 |
| **JOHNSTONE STRAIT** | | |
| ADAM RIVER | 5,000 | 77,100 |
| KOKISH RIVER | 5,000 | 20,100 |
| NIMPKISH RIVER | 110,000 | 99,300 |
| SALMON RIVER | 20,000 | 208,100 |
| TOTAL | 140,000 | 404,600 |
| **LOUGHBOROUGH/BUTE INLETS** | | |
| GRASSY CREEK | 100 | 4,100 |
| HEYDON CREEK | 35,000 | 15,000 |
| READ CREEK | 100 | 5,200 |
| WORTLEY CREEK | 100 | 3,600 |
| TOTAL | 35,300 | 27,900 |

| REGION/SYSTEM | TARGET | HABITAT |
|---|---|---|
| **MID VANCOUVER ISLAND** | | |
| CHEF CREEK | 5,000 | 7,700 |
| COWIE CREEK | 2,000 | 900 |
| ENGLISHMAN RIVER | 4,000 | 42,500 |
| FRENCH CREEK | 1,000 | 900 |
| LITTLE QUALICUM RIVER | 130,000 | 72,100 |
| MCNAUGHTON CREEK | 2,000 | 3,800 |
| NILE CREEK | 1,000 | 500 |
| OYSTER RIVER | 3,500 | 10,800 |
| PUNTLEDGE RIVER | 60,000 | 55,500 |
| QUALICUM RIVER | 100,000 | 75,000 |
| ROSEWALL CREEK | 200 | 8,700 |
| TSABLE RIVER | 7,000 | 9,500 |
| TSOLUM RIVER | 1,500 | 44,900 |
| WATERLOO CREEK | 2,000 | 1,300 |
| WILFRED CREEK | 2,500 | 4,600 |
| TOTAL | 321,700 | 338,700 |
| **LOWER VANCOUVER ISLAND** | | |
| BONELL CREEK | 10,000 | 6,000 |
| BONSALL CREEK | 3,000 | 500 |
| BUSH CREEK | 10,000 | 4,500 |
| HOLLAND CREEK | 10,000 | 1,800 |
| NANAIMO RIVER | 65,000 | 76,600 |
| NANOOSE CREEK | 15,000 | 14,600 |
| STOCKING CREEK | 8,000 | 1,300 |
| WALKERS CREEK | 1,500 | 200 |
| TOTAL | 122,500 | 105,500 |
| **SOUTH VANCOUVER ISLAND** | | |
| CHEMAINUS RIVER | 50,000 | 21,200 |
| COWICHAN RIVER | 110,000 | 158,700 |
| GOLDSTREAM RIVER | 15,000 | 6,500 |
| KOKSILAH RIVER | 20,000 | 13,300 |
| TOTAL | 195,000 | 199,700 |

| REGION/SYSTEM | TARGET | HABITAT |
|---|---|---|
| **FRASER RIVER** | | |
| CHEHALIS RIVER | 200,000 | 44,000 |
| HARRISION RIVER | 175,000 | 125,840 |
| INCH CREEK | 5,000 | 5,500 |
| SQUAKUM CREEK | 15,000 | 8,800 |
| STAVE RIVER | 100,000 | 115,500 |
| WEAVER CREEK | 22,000 | 11,000 |
| TOTAL | 517,000 | 310,640 |

Table 5.1. Fraser River Wild Chum data

| BY | GrossEsc | FY | TotalCpue | TotalRet | TotalFry | Ret/spawn | Ret/fry_cpue | prop3 | prop4 | prop5 | totalprod |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1959 | 152300.00 | 1960 | | 390406.74 | | 2.56 | | 0.45 | 0.54 | 0.02 | 147902.22 |
| 1960 | 144782.00 | 1961 | | 400116.37 | | 2.76 | | 0.32 | 0.67 | 0.01 | 161876.23 |
| 1961 | 103945.00 | 1962 | | 156512.52 | | 1.51 | | 0.35 | 0.62 | 0.03 | 253407.35 |
| 1962 | 130357.00 | 1963 | | 315789.99 | | 2.42 | | 0.18 | 0.81 | 0.01 | 136773.53 |
| 1963 | 192245.00 | 1964 | | 151652.27 | | 0.79 | | 0.27 | 0.70 | 0.03 | 316579.63 |
| 1964 | 246741.00 | 1965 | 1259.93 | 1063848.75 | | 4.31 | 844.37 | 0.17 | 0.81 | 0.02 | 388414.91 |
| 1965 | 129484.00 | 1966 | 809.46 | 491327.14 | 18693.00 | 3.79 | 606.98 | 0.37 | 0.62 | 0.01 | 546850.18 |
| 1966 | 360835.00 | 1967 | 1459.83 | 1009655.46 | 33302.00 | 2.80 | 691.63 | 0.28 | 0.68 | 0.04 | 330561.36 |
| 1967 | 213873.00 | 1968 | 1074.19 | 268774.16 | 23764.00 | 1.26 | 250.21 | 0.21 | 0.69 | 0.10 | 270694.00 |
| 1968 | 670528.00 | 1969 | 1450.17 | 1865063.01 | 31631.00 | 2.78 | 1284.45 | 0.08 | 0.71 | 0.21 | 204470.82 |
| 1969 | 309245.00 | 1970 | 1968.75 | 1880298.93 | 42825.00 | 6.08 | 955.07 | 0.05 | 0.85 | 0.09 | 435616.75 |
| 1970 | 284275.00 | 1971 | | 435789.36 | | 1.53 | | 0.11 | 0.85 | 0.04 | 310694.69 |
| 1971 | 290150.00 | 1972 | 707.70 | 385428.82 | 16467.00 | 1.33 | 544.62 | 0.38 | 0.58 | 0.04 | 358080.80 |
| 1972 | 423290.00 | 1973 | 2397.64 | 1174026.53 | 53201.00 | 2.77 | 489.66 | 0.24 | 0.74 | 0.01 | 131410.70 |
| 1973 | 267105.00 | 1974 | 1278.73 | 736699.04 | 30695.00 | 2.76 | 576.12 | 0.22 | 0.74 | 0.04 | 436420.73 |
| 1974 | 350390.00 | 1975 | 1835.45 | 1446851.74 | 40241.00 | 4.13 | 788.28 | 0.13 | 0.84 | 0.03 | 429166.11 |
| 1975 | 191445.00 | 1976 | 466.84 | 344975.01 | 10381.00 | 1.80 | 738.95 | 0.60 | 0.38 | 0.02 | 509728.09 |
| 1976 | 340542.00 | 1977 | 2308.98 | 902606.00 | 51711.00 | 2.65 | 390.91 | 0.14 | 0.82 | 0.04 | 238195.07 |
| 1977 | 599366.00 | 1978 | 1162.72 | 755062.82 | 26992.00 | 1.26 | 649.19 | 0.40 | 0.53 | 0.07 | 316650.27 |
| 1978 | 359065.00 | 1979 | 776.44 | 641220.95 | 16660.00 | 1.78 | 824.65 | 0.11 | 0.71 | 0.18 | 409191.32 |
| 1979 | 255634.00 | 1980 | 858.72 | 391157.45 | 19809.00 | 1.53 | 455.51 | 0.31 | 0.63 | 0.05 | 350816.58 |
| 1980 | 312141.00 | 1981 | 1413.28 | 329015.65 | 32004.50 | 1.05 | 232.80 | 0.24 | 0.64 | 0.12 | 392560.29 |
| 1981 | 435316.00 | 1982 | 2751.97 | 1352521.98 | 60424.00 | 3.11 | 491.45 | 0.17 | 0.74 | 0.08 | 598875.06 |
| 1982 | 320291.00 | 1983 | 3464.42 | 1799067.18 | 81042.00 | 5.62 | 519.30 | 0.34 | 0.63 | 0.03 | 1240133.21 |
| 1983 | 364991.00 | 1984 | 1651.47 | 629936.19 | 36811.00 | 1.72 | 379.25 | 0.27 | 0.52 | 0.20 | 877449.80 |
| 1984 | 433266.00 | 1985 | 1821.78 | 987083.92 | 41938.50 | 2.28 | 541.12 | 0.05 | 0.75 | 0.20 | 527084.66 |
| 1985 | 1295255.00 | 1986 | 1440.89 | 702251.53 | 34259.00 | 0.54 | 486.21 | 0.09 | 0.77 | 0.13 | 604650.49 |
| 1986 | 972927.00 | 1987 | 2736.50 | 2040923.63 | 58830.50 | 2.09 | 743.71 | 0.06 | 0.72 | 0.22 | 641755.86 |
| 1987 | 398343.00 | 1988 | 1855.70 | 612835.12 | 36477.50 | 1.52 | 327.19 | 0.03 | 0.83 | 0.13 | 794029.47 |
| 1988 | 585317.00 | 1989 | 1785.24 | 1283717.79 | 38822.00 | 2.16 | 709.18 | 0.11 | 0.65 | 0.23 | 742804.53 |
| 1989 | 585552.00 | 1990 | 1048.70 | 1355336.57 | 19862.00 | 2.28 | 1270.49 | 0.03 | 0.60 | 0.36 | 567255.16 |
| 1990 | 988875.00 | 1991 | 1748.00 | 1645552.03 | 39898.50 | 1.66 | 937.78 | 0.03 | 0.74 | 0.23 | 862505.73 |
| 1991 | 859274.00 | 1992 | 1255.91 | 1286122.43 | 47688.50 | 1.50 | 1023.67 | 0.14 | 0.80 | 0.06 | 219292.71 |
| 1992 | 741618.00 | 1993 | 1840.76 | 988585.03 | 42907.00 | 1.33 | 537.05 | 0.37 | 0.60 | 0.03 | |
| 1993 | 809578.00 | 1994 | 487.03 | 759383.22 | 19971.00 | 0.94 | 1559.22 | 0.27 | 0.73 | 0.00 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 1498436.00 | 1995 | 2696.85 | 93299.59 | 59815.50 | 0.06 | 34.60 | 1.00 | 0.00 | 0.00 |
| 1995 | 1673067.00 | 1996 | 1124.67 | 0.00 | 22915.50 | 0.00 | 0.00 | | | |
| 1996 | 867582 | 1997 | | 0 | | 0 | | | | |
| 1997 | 656946 | 1998 | | 0 | | 0 | | | | |
| 1998 | 2600000 | 1999 | | 0 | | | | | | |

Table 5.2 Production of all wild chum salmon from the Study Area including Fraser River and non-Fraser River stocks.

| | | | | Age Composition | | | Brood Return | | | | Percent Return at | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Escapement | Catch | Total Return | Age3 | Age4 | Age5 | Age3 | Age4 | Age5 | Total Brood | Age3 | Age4 | Age5 |
| 1953 | 939,750 | 2,342,945 | 3,282,695 | | | | - | - | 28,737 | 28,737 | 0.0% | 0.0% | 100.0% |
| 1954 | 1,074,575 | 3,006,207 | 4,080,782 | | | | - | 1,602,068 | 52,657 | 1,654,725 | 0.0% | 96.8% | 3.2% |
| 1955 | 605,950 | 717,079 | 1,323,029 | | | | 843,956 | 1,412,919 | 13,650 | 2,270,525 | 37.2% | 62.2% | 0.6% |
| 1956 | 472,826 | 648,516 | 1,121,342 | | | | 654,368 | 762,565 | 24,812 | 1,441,745 | 45.4% | 52.9% | 1.7% |
| 1957 | 1,005,305 | 532,022 | 1,537,327 | | | | 549,109 | 820,260 | 20,603 | 1,389,973 | 39.5% | 59.0% | 1.5% |
| 1958 | 1,127,425 | 1,347,335 | 2,474,760 | 34.1% | 64.7% | 1.2% | 114,688 | 204,981 | 17,412 | 337,081 | 34.0% | 60.8% | 5.2% |
| 1959 | 908,275 | 1,211,669 | 2,119,944 | 30.9% | 66.6% | 2.5% | 688,383 | 594,380 | 19,273 | 1,302,036 | 52.9% | 45.7% | 1.5% |
| 1960 | 626,002 | 699,323 | 1,325,325 | 41.4% | 57.5% | 1.0% | 360,008 | 801,168 | 9,209 | 1,170,385 | 30.8% | 68.5% | 0.8% |
| 1961 | 580,349 | 379,411 | 959,760 | 11.9% | 85.5% | 2.6% | 161,879 | 241,266 | 10,262 | 413,407 | 39.2% | 58.4% | 2.5% |
| 1962 | 624,825 | 289,143 | 913,968 | 75.3% | 22.4% | 2.3% | 139,239 | 611,803 | 10,550 | 761,592 | 18.3% | 80.3% | 1.4% |
| 1963 | 631,701 | 331,393 | 963,094 | 37.4% | 61.7% | 1.8% | 98,842 | 293,071 | 10,299 | 402,211 | 24.6% | 72.9% | 2.6% |
| 1964 | 777,793 | 198,103 | 975,896 | 16.6% | 82.1% | 2.0% | 504,276 | 1,796,457 | 50,861 | 2,351,594 | 21.4% | 76.4% | 2.2% |
| 1965 | 327,196 | 62,518 | 389,714 | 35.7% | 61.9% | 2.4% | 382,879 | 724,234 | 13,526 | 1,120,640 | 34.2% | 64.6% | 1.2% |
| 1966 | 880,817 | 93,923 | 974,740 | 10.1% | 62.8% | 1.1% | 669,042 | 1,841,316 | 80,833 | 2,591,190 | 25.8% | 71.1% | 3.1% |
| 1967 | 674,940 | 167,743 | 842,683 | 59.8% | 34.8% | 1.3% | 150,953 | 359,164 | 72,647 | 582,765 | 25.9% | 61.6% | 12.5% |
| 1968 | 1,601,617 | 728,231 | 2,329,848 | 16.4% | 77.1% | 0.4% | 298,187 | 3,561,127 | 827,267 | 4,686,580 | 6.4% | 76.0% | 17.7% |
| 1969 | 913,334 | 553,128 | 1,466,462 | 45.6% | 49.4% | 3.5% | 268,643 | 3,393,966 | 442,132 | 4,104,742 | 6.5% | 82.7% | 10.8% |
| 1970 | 1,031,031 | 974,764 | 2,005,795 | 7.5% | 91.8% | 0.7% | 101,208 | 946,588 | 35,001 | 1,082,797 | 9.3% | 87.4% | 3.2% |
| 1971 | 572,296 | 165,888 | 738,184 | 40.4% | 48.7% | 11.0% | 373,020 | 470,880 | 31,181 | 875,081 | 42.6% | 53.8% | 3.6% |
| 1972 | 1,765,522 | 2,136,895 | 3,902,417 | 6.9% | 91.3% | 1.9% | 604,474 | 1,684,796 | 31,396 | 2,320,667 | 26.0% | 72.6% | 1.4% |
| 1973 | 1,428,407 | 2,894,034 | 4,322,441 | 2.3% | 78.5% | 19.1% | 314,984 | 1,149,883 | 56,861 | 1,521,728 | 20.7% | 75.6% | 3.7% |
| 1974 | 1,147,371 | 620,476 | 1,767,847 | 21.1% | 53.5% | 25.0% | 394,831 | 2,338,218 | 97,232 | 2,830,282 | 14.0% | 82.6% | 3.4% |
| 1975 | 562,907 | 547,449 | 1,110,356 | 54.4% | 42.4% | 3.2% | 395,247 | 301,396 | 16,242 | 712,884 | 55.4% | 42.3% | 2.3% |
| 1976 | 871,498 | 1,159,464 | 2,030,962 | 15.5% | 83.0% | 1.5% | 284,811 | 1,657,179 | 94,346 | 2,036,336 | 14.0% | 81.4% | 4.6% |
| 1977 | 1,353,794 | 222,316 | 1,576,110 | 25.1% | 73.0% | 2.0% | 677,150 | 1,108,656 | 204,774 | 1,990,579 | 34.0% | 55.7% | 10.3% |
| 1978 | 1,313,647 | 1,476,679 | 2,790,326 | 14.2% | 83.8% | 2.0% | 192,912 | 1,802,149 | 321,254 | 2,316,315 | 8.3% | 77.8% | 13.9% |
| 1979 | 627,637 | 93,965 | 721,602 | 39.5% | 41.8% | 13.5% | 487,913 | 679,941 | 72,036 | 1,239,890 | 39.4% | 54.8% | 5.8% |
| 1980 | 1,274,157 | 1,076,413 | 2,350,570 | 28.8% | 70.5% | 0.7% | 215,604 | 707,251 | 90,769 | 1,013,623 | 21.3% | 69.8% | 9.0% |
| 1981 | 1,253,118 | 142,796 | 1,395,914 | 13.8% | 79.4% | 6.8% | 793,072 | 2,270,766 | 264,812 | 3,328,650 | 23.8% | 68.2% | 8.0% |
| 1982 | 1,255,989 | 1,265,512 | 2,521,501 | 19.4% | 71.5% | 8.1% | 1,396,594 | 2,636,813 | 191,996 | 4,225,403 | 33.1% | 62.4% | 4.5% |
| 1983 | 1,024,844 | 192,599 | 1,217,443 | 17.7% | 55.8% | 26.4% | 396,791 | 1,124,910 | 396,481 | 1,918,183 | 20.7% | 58.6% | 20.7% |
| 1984 | 1,454,932 | 120,551 | 1,575,483 | 50.3% | 44.9% | 4.6% | 160,092 | 2,294,481 | 358,681 | 2,813,254 | 5.7% | 81.6% | 12.7% |
| 1985 | 2,603,153 | 1,154,975 | 3,758,128 | 37.2% | 60.4% | 2.4% | 197,872 | 962,910 | 190,183 | 1,350,965 | 14.6% | 71.3% | 14.1% |
| 1986 | 1,824,021 | 1,474,395 | 3,298,416 | 12.0% | 79.9% | 8.0% | 206,600 | 2,948,162 | 1,056,378 | 4,211,139 | 4.9% | 70.0% | 25.1% |
| 1987 | 1,117,826 | 367,656 | 1,485,482 | 10.8% | 75.7% | 12.9% | 38,051 | 1,184,721 | 217,408 | 1,440,180 | 2.6% | 82.3% | 15.1% |
| 1988 | 1,440,289 | 1,450,559 | 2,890,848 | 6.8% | 79.4% | 13.7% | 335,789 | 2,222,487 | 832,962 | 3,391,238 | 9.9% | 65.5% | 24.6% |
| 1989 | 874,797 | 690,473 | 1,565,270 | 13.2% | 61.5% | 22.9% | 103,324 | 2,325,696 | 1,045,479 | 3,474,499 | 3.0% | 66.9% | 30.1% |
| 1990 | 1,593,336 | 1,585,638 | 3,178,974 | 1.2% | 92.7% | 6.0% | 148,510 | 2,617,604 | 536,074 | 3,302,188 | 4.5% | 79.3% | 16.2% |
| 1991 | 1,798,272 | 801,800 | 2,600,072 | 12.9% | 45.6% | 40.6% | 394,378 | 1,466,764 | 132,150 | 1,993,293 | 19.8% | 73.6% | 6.6% |
| 1992 | 1,927,215 | 1,197,671 | 3,124,886 | 3.3% | 71.1% | 7.0% | 517,126 | 1,061,713 | 73,226 | 1,652,065 | 31.3% | 64.3% | 4.4% |
| 1993 | 1,872,917 | 1,467,088 | 3,340,005 | 4.4% | 69.6% | 24.9% | - | - | - | - | - | - | - |
| 1994 | 2,500,740 | 1,594,867 | 4,095,607 | 9.6% | 63.9% | 25.5% | - | - | - | - | - | - | - |
| 1995 | 1,958,886 | 593,824 | 2,552,710 | 20.3% | 57.5% | 21.0% | - | - | - | - | - | - | - |
| 1996 | 1,243,465 | 329,599 | 1,573,064 | 23.4% | 67.5% | 8.4% | - | - | - | - | - | - | - |
| 1997 | 1,136,778 | 413,930 | 1,550,708 | 13.7% | 81.5% | 4.7% | - | - | - | - | - | - | - |
| 1998 | - | 2,042,679 | 2,042,679 | 12.2% | 82.8% | 4.9% | - | - | - | - | - | - | - |

Table 5.3 Comparison of Stock Recruitment Parameters

| | ALL DATA WILD | BEACHAMS TECH REP NO. 1270 | JOYCE&CASS PSARC 92-02 | CURRENT FRASER RIVER DATA |
|---|---|---|---|---|
| a' | 1.01 | 0.48 | 1.06 | 1.07 |
| b' | 2,659,444 | 6,190,000 | 1,139,785 | 1,737,787 |
| Umsy | 0.44 | 0.22 | 0.45 | 0.46 |
| Smax = | 2,620,950 | 12,896,000 | 1,075,269 | 1,623,566 |
| Rmax = | 2,659,830 | 7,667,000 | 1,141,760 | 1,741,900 |
| Smsy = | 1,140,863 | 2,887,000 | 485,320 | 738,690 |
| Rmsy = | 2,036,482 | 3,730,000 | 891,996 | 1,366,832 |
| Harv.Surp = | 895,619 | 843,000 | 406,675 | 628,141 |

Table 6.1 Results of Heuristic Prediction of Total Returns

| Brood Year | Regression Parameters b0 | b1 | Fry Cpue | Predicted Total Returns | Total Returns | Percent Difference |
|---|---|---|---|---|---|---|
| 1986 | 101,897 | 540 | 2,380 | 1,387,389 | 2,040,924 | 32.02% |
| 1987 | 96,570 | 530 | 2,900 | 1,633,978 | 612,835 | -166.63% |
| 1988 | 101,189 | 534 | 2,890 | 1,642,806 | 1,283,718 | -27.97% |
| 1989 | 176,592 | 504 | 2,441 | 1,405,645 | 1,355,337 | -3.71% |
| 1990 | 188,019 | 511 | 2,992 | 1,715,716 | 1,645,552 | -4.26% |
| 1991 | 223,635 | 499 | 3,187 | 1,813,134 | 1,286,122 | -40.98% |
| 1992 | 222,872 | 496 | 3,173 | 1,796,345 | 988,585 | -81.71% |

| METHOD | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | MPE | MAPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1) PRE- AND EARLY SEASON** | | | | | | | | | | | | |
| **PRE-SEASON** | 29.5% | 91.0% | -17.0% | 31.2% | -1.7% | -37.3% | 5.0% | 172.9% | 242.9% | 259.0% | 77.6% | 88.8% |
| **TEST FISHING** | | | | | | | | | | | | |
| Test Fishing Week 9/4 | -45.5% | 60.4% | 2.8% | 27.9% | -18.7% | -50.6% | -2.9% | 15.0% | 133.9% | 33.5% | 15.6% | 39.1% |
| **COMMERCIAL FISHERY** | | | | | | | | | | | | |
| Commercial Week 9/4 Total Catch | -15.6% | 64.7% | -3.9% | 8.2% | 4.2% | -45.5% | -10.3% | 22.4% | 60.5% | | 9.4% | 26.2% |
| Commercial Week 9/4 Seine Catch | -3.6% | 87.0% | 3.1% | 13.4% | 8.0% | -44.9% | -11.8% | -30.7% | 74.6% | 50.0% | 10.6% | 32.7% |
| Comercial Week 9/4 Seine CPE | -18.1% | 56.5% | -15.5% | -0.1% | 8.0% | -46.7% | -24.5% | 32.3% | 133.9% | 33.5% | 14.0% | 36.9% |
| **WEIGHTED** | | | | | | | | | | | | |
| Test Fishing CPE Week 9/4 & Total Commercial Fishery Total Catch Week 9/4 | -27.2% | 63.1% | -0.8% | 23.8% | -5.3% | -47.3% | -7.1% | 18.7% | 70.1% | | 9.8% | 29.3% |
| Test Fishing CPE Week 9/4 & Total Commercial Fishery Seine Catch Week 9/4 | -20.1% | 76.5% | 3.0% | 27.3% | -3.2% | -46.8% | -7.8% | -8.5% | 77.9% | 31.9% | 13.0% | 30.3% |
| Test Fishing CPE Week 9/4 & Total Commercial Fishery Seine CPE Week 9/4 | -31.3% | 58.4% | -8.2% | 19.6% | -14.0% | -48.3% | -13.3% | 22.8% | 107.4% | 39.4% | 13.2% | 36.3% |
| **2) MID-SEASON** | | | | | | | | | | | | |
| **TEST FISHING** | | | | | | | | | | | | |
| Test Fishing Week 9/4 To 10/2 | -33.2% | 71.3% | 12.3% | 8.5% | -19.4% | -25.3% | 28.1% | 62.1% | 78.8% | 67.1% | 25.0% | 40.6% |
| **COMMERCIAL FISHERY** | | | | | | | | | | | | |
| Commercial Week 10/2 Total Catch | | | 53.4% | | -2.6% | | 7.9% | | | | 19.6% | 21.3% |
| Commercial Week 10/2 Seine Catch | | | 40.8% | | 1.9% | | 5.6% | | | | 16.1% | 16.1% |
| Comercial Week 10/2 Seine CPE | | | 11.8% | | -9.8% | | 13.9% | | | | 5.3% | 11.8% |
| **WEIGHTED** | | | | | | | | | | | | |
| Test Fishing CPE Week 9/4 To 10/2 & Total Commercial Fishery Total Catch Week 10/2 | | | 35.0% | | -13.7% | | 17.9% | | | | 13.1% | 22.2% |
| Test Fishing CPE Week 9/4 To 10/2 & Total Commercial Fishery Seine Catch Week 10/2 | | | 27.3% | | -7.6% | | 15.9% | | | | 11.9% | 16.9% |
| Test Fishing CPE Week 9/4 To 10/2 & Total Commercial Fishery Seine CPE Week 10/2 | | | 12.0% | | 20.2% | | 19.7% | | | | 17.3% | 17.3% |
| **3) END OF SEASON** | | | | | | | | | | | | |
| **TEST FISHING** | | | | | | | | | | | | |
| Test Fishing Week 9/4 To 10/3 | 2.1% | 57.9% | 9.5% | 4.5% | -12.6% | -18.6% | 41.2% | 59.4% | 123.2% | 86.2% | 35.3% | 41.5% |
| **COMMERCIAL FISHERY** | | | | | | | | | | | | |
| Commercial Week 10/4 Total Catch | 37.7% | 50.7% | 12.6% | | 10.1% | 10.7% | -25.1% | | | | 16.1% | 24.5% |
| Commercial Week 10/4 Seine Catch | 58.1% | 75.9% | 9.3% | | 1.1% | 16.3% | -17.4% | | | | 23.9% | 29.7% |
| Comercial Week 10/4 Seine CPE | 18.4% | 53.4% | -0.1% | | 9.1% | 24.0% | -14.7% | | | | 15.0% | 20.0% |
| **WEIGHTED** | | | | | | | | | | | | |
| Test Fishing CPE Week 9/4 To 10/3 & Total Commercial Fishery Total Catch Week 10/4 | 17.0% | 54.5% | 10.8% | | -3.4% | -5.1% | 26.2% | | | | 16.7% | 19.5% |
| Test Fishing CPE Week 9/4 To 10/3 & Total Commercial Fishery Seine Catch Week 10/4 | 30.0% | 67.1% | 9.4% | | -6.8% | -3.1% | 23.7% | | | | 20.1% | 23.4% |
| Test Fishing CPE Week 9/4 To 10/3 & Total Commercial Fishery Seine CPE Week 10/4 | 8.7% | 55.1% | 4.7% | | -3.2% | 3.6% | 26.4% | | | | 15.9% | 17.0% |

Table 7.1. Performance of various models for estimating run size to Clockwork chum stocks (1988-1997) at three stages of the return migration. MPE = mean percent error and MAPE = mean absolute percent error.

| METHOD | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1) PRE- AND EARLY SEASON** | | | | | | | | | | |
| **PRE-SEASON** | 4,089,000 | 3,329,000 | 2,929,000 | 3,279,000 | 4,111,000 | 2,657,000 | 4,205,000 | 4,187,000 | 4,197,000 | 4,965,000 |
| **TEST FISHING** | | | | | | | | | | |
| Test Fishing Week 9/4 | 1,722,000 | 2,796,000 | 3,628,000 | 3,196,000 | 3,399,000 | 2,092,000 | 3,889,000 | 1,764,000 | 2,863,000 | 1,846,000 |
| **COMMERCIAL FISHERY** | | | | | | | | | | |
| Commercial Week 9/4 Total Catch | 2,663,000 | 2,871,000 | 3,389,000 | 2,704,000 | 4,360,000 | 2,308,000 | 3,592,000 | 1,877,000 | 1,965,000 | |
| Commercial Week 9/4 Seine Catch | 3,044,000 | 3,259,000 | 3,639,000 | 2,833,000 | 4,517,000 | 2,335,000 | 3,533,000 | 1,063,000 | 2,137,000 | 2,075,000 |
| Comercial Week 9/4 Seine CPE | 2,586,000 | 2,727,000 | 2,981,000 | 2,496,000 | 4,517,000 | 2,258,000 | 3,024,000 | 2,030,000 | 2,863,000 | 1,846,000 |
| **WEIGHTED** | | | | | | | | | | |
| Test Fishing CPE Week 9/4 & Total Commercial Fishery Total Catch Week 9/4 | 2,297,000 | 2,842,000 | 3,500,000 | 3,094,000 | 3,963,000 | 2,233,000 | 3,722,000 | 1,821,000 | 2,082,000 | |
| Test Fishing CPE Week 9/4 & Total Commercial Fishery Seine Catch Week 9/4 | 2,522,000 | 3,076,000 | 3,634,000 | 3,181,000 | 4,050,000 | 2,252,000 | 3,694,000 | 1,403,000 | 2,177,000 | 1,824,000 |
| Test Fishing CPE Week 9/4 & Total Commercial Fishery Seine CPE Week 9/4 | 2,170,000 | 2,761,000 | 3,239,000 | 2,988,000 | 3,596,000 | 2,188,000 | 3,472,000 | 1,883,000 | 2,538,000 | 1,928,000 |
| **2) MID-SEASON** | | | | | | | | | | |
| **TEST FISHING** | | | | | | | | | | |
| Test Fishing Week 9/4 To 10/2 | 2,109,000 | 2,985,000 | 3,962,000 | 2,712,000 | 3,373,000 | 3,163,000 | 5,129,000 | 2,486,000 | 2,189,000 | 2,311,000 |
| **COMMERCIAL FISHERY** | | | | | | | | | | |
| Commercial Week 10/2 Total Catch | | | 5,411,000 | | 4,076,000 | | 4,320,000 | | | |
| Commercial Week 10/2 Seine Catch | | | 4,967,000 | | 4,264,000 | | 4,231,000 | | | |
| Comercial Week 10/2 Seine CPE | | | 3,944,000 | | 3,772,000 | | 4,561,000 | | | |
| **WEIGHTED** | | | | | | | | | | |
| Test Fishing CPE Week 9/4 To 10/2 & Total Commercial Fishery Total Catch Week 10/2 | | | 4,762,000 | | 3,608,000 | | 4,723,000 | | | |
| Test Fishing CPE Week 9/4 To 10/2 & Total Commercial Fishery Seine Catch Week 10/2 | | | 4,492,000 | | 3,865,000 | | 4,640,000 | | | |
| Test Fishing CPE Week 9/4 To 10/2 & Total Commercial Fishery Seine CPE Week 10/2 | | | 3,951,000 | | 5,030,000 | | 4,792,000 | | | |
| **3) END OF SEASON** | | | | | | | | | | |
| **TEST FISHING** | | | | | | | | | | |
| Test Fishing Week 9/4 To 10/3 | 3,222,000 | 2,753,000 | 3,862,000 | 2,612,000 | 3,655,000 | 3,446,000 | 5,654,000 | 2,445,000 | 2,732,000 | 2,575,000 |
| **COMMERCIAL FISHERY** | | | | | | | | | | |
| Commercial Week 10/4 Total Catch | 4,346,000 | 2,627,000 | 3,974,000 | | 4,606,000 | 4,689,000 | 3,000,000 | | | |
| Commercial Week 10/4 Seine Catch | 4,991,000 | 3,066,000 | 3,856,000 | | 4,227,000 | 4,927,000 | 3,310,000 | | | |
| Comercial Week 10/4 Seine CPE | 3,739,000 | 2,674,000 | 3,525,000 | | 4,564,000 | 5,254,000 | 3,415,000 | | | |
| **WEIGHTED** | | | | | | | | | | |
| Test Fishing CPE Week 9/4 To 10/3 & Total Commercial Fishery Total Catch Week 10/4 | 3,693,000 | 2,693,000 | 3,909,000 | | 4,041,000 | 4,021,000 | 5,056,000 | | | |
| Test Fishing CPE Week 9/4 To 10/3 & Total Commercial Fishery Seine Catch Week 10/4 | 4,104,000 | 2,912,000 | 3,860,000 | | 3,900,000 | 4,104,000 | 4,956,000 | | | |
| Test Fishing CPE Week 9/4 To 10/3 & Total Commercial Fishery Seine CPE Week 10/4 | 3,432,000 | 2,704,000 | 3,693,000 | | 4,048,000 | 4,389,000 | 5,064,000 | | | |
| **ACTUAL RUN SIZE** | 3,157,000 | 1,743,000 | 3,528,000 | 2,499,000 | 4,183,000 | 4,236,000 | 4,005,000 | 1,534,000 | 1,224,000 | 1,383,000 |

Table 7.2. Comparison of estimated run size for different run size models to the actual run size for Clockwork chum salmon.

Table 8.1: Estimated model parameters (standard error in parentheses) for data from 1968 to 1996

| **Stock** | **ARIMA (p,d,q)** | f | q | m | b | $s_e^2$ | **AIC** |
|---|---|---|---|---|---|---|---|
| Fraser River | (0,0,0) | NA | NA | 0.795 (0.115) | 0.478 (0.166) | 0.200 | 37.613 |
| | (1,0,0) | 0.132 (0.198) | NA | 0.805 (0.133) | 0.455 (0.191) | 0.204 | 39.048 |
| | (0,0,1) | NA | -0.170 (0.199) | 0.806 (0.134) | 0.452 (0.193) | 0.203 | 38.885 |
| Non-Fraser River | (0,0,0) | NA | NA | 1.272 (0.155) | -0.178 (0.223) | 0.361 | 54.723 |
| | (1,0,0) | -0.015 (0.201) | NA | 1.272 (0.157) | -0.183 (0.227) | 0.379 | 56.978 |
| | (0,0,1) | NA | 0.024 (0.201) | 1.271 (0.155) | -0.182 (0.225) | 0.378 | 56.953 |
| Total | (0,0,0) | NA | NA | 2.067 (0.245) | 0.300 (0.353) | 0.903 | 81.324 |
| | (1,0,0) | -0.042 (0.200) | NA | 2.063 (0.241) | 0.304 (0.348) | 0.944 | 83.454 |
| | (0,0,1) | NA | 0.075 (0.199) | 2.059 (0.233) | 0.313 (0.337) | 0.942 | 83.417 |

Table 8.2: Estimated model parameters (standard error in parentheses) for data from 1974 to 1996.

| **Stock** | **ARIMA (p,d,q)** | f | q | m | b | $s_e^2$ | **AIC** |
|---|---|---|---|---|---|---|---|
| Fraser River | (0,0,0) | NA | NA | 0.712 (0.150) | 0.561 (0.193) | 0.203 | 30.649 |
| | (1,0,0) | 0.119 (0.226) | NA | 0.725 (0.171) | 0.536 (0.218) | 0.211 | 32.240 |
| | (0,0,1) | NA | -0.134( 0.229) | 0.724 (0.171) | 0.537 (0.219) | 0.210 | 32.195 |
| Non-Fraser River | (0,0,0) | NA | NA | 1.093 (0.153) | 0.001 (0.195) | 0.209 | 31.287 |
| | (1,0,0) | -0.259 (0.226) | NA | 1.074 (0.124) | 0.035 (0.161) | 0.210 | 32.257 |
| | (0,0,1) | NA | 0.436 (0.228) | 1.069 (0.093) | 0.062 (0.125) | 0.205 | 31.788 |
| Total | (0,0,0) | NA | NA | 1.805 (0.263) | 0.562 (0.337) | 0.623 | 56.409 |
| | (1,0,0) | -0.243 (0.225) | NA | 1.772 (0.216) | 0.622 (0.279) | 0.626 | 57.379 |
| | (0,0,1) | NA | 0.396 (0.207) | 1.749 (0.167) | 0.672 (0.217) | 0.607 | 56.735 |

Appendix 1 Contribution of Inner South Coast enhanced stocks by brood year by age by facility to catch and escapement.

**Non Fraser Enhanced Stocks (Puntledge, Big & Little Qualicum)**

| | Catch at Age | | | | | | Escapement at Age | | | | | | Catch + Escapement at Age | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Br.Yr.** | **2** | **3** | **4** | **5** | **6** | **Total** | **2** | **3** | **4** | **5** | **6** | **Total** | **2** | **3** | **4** | **5** | **6** | **Total** |
| 1977 | 0 | 35,304 | 38,671 | 6,906 | 0 | 80,881 | 0 | 34,801 | 74,168 | 4,632 | 0 | 113,601 | 0 | 70,105 | 112,839 | 11,538 | 0 | 194,482 |
| 1978 | 0 | 6,270 | 151,703 | 12,500 | 0 | 170,472 | 0 | 12,026 | 101,750 | 13,466 | 0 | 127,242 | 0 | 18,296 | 253,453 | 25,966 | 0 | 297,714 |
| 1979 | 0 | 56,729 | 88,608 | 14,866 | 0 | 160,204 | 0 | 48,423 | 140,987 | 7,281 | 0 | 196,691 | 0 | 105,152 | 229,595 | 22,147 | 0 | 356,895 |
| 1980 | 0 | 10,682 | 69,072 | 3,505 | 0 | 83,259 | 0 | 25,882 | 49,777 | 0 | 0 | 75,659 | 0 | 36,564 | 118,849 | 3,505 | 0 | 158,918 |
| 1981 | 0 | 93,376 | 311,081 | 19,086 | 0 | 423,543 | 0 | 86,426 | 102,217 | 5,427 | 0 | 194,070 | 0 | 179,802 | 413,298 | 24,513 | 0 | 617,613 |
| 1982 | 0 | 271,623 | 511,376 | 35,493 | 2,149 | 820,641 | 0 | 171,802 | 267,527 | 34,683 | 1,887 | 475,899 | 0 | 443,425 | 778,903 | 70,176 | 4,036 | 1,296,540 |
| 1983 | 0 | 55,819 | 233,651 | 55,121 | 1,432 | 346,023 | 0 | 16,307 | 105,241 | 27,290 | 222 | 149,060 | 0 | 72,126 | 338,892 | 82,411 | 1,654 | 495,083 |
| 1984 | 0 | 8,394 | 132,885 | 35,196 | 92 | 176,567 | 0 | 2,830 | 102,892 | 27,621 | 0 | 133,343 | 0 | 11,224 | 235,777 | 62,817 | 92 | 309,910 |
| 1985 | 0 | 8,828 | 81,152 | 7,853 | 0 | 97,833 | 0 | 4,445 | 55,863 | 7,110 | 1 | 67,419 | 0 | 13,273 | 137,015 | 14,963 | 1 | 165,252 |
| 1986 | 0 | 29,207 | 304,537 | 142,029 | 4,933 | 480,706 | 0 | 21,819 | 143,212 | 38,203 | 337 | 203,571 | 0 | 51,026 | 447,749 | 180,232 | 5,270 | 684,277 |
| 1987 | 0 | 3,369 | 135,439 | 83,188 | 2,022 | 224,019 | 0 | 1,407 | 81,221 | 9,365 | 0 | 91,993 | 0 | 4,776 | 216,660 | 92,553 | 2,022 | 316,012 |
| 1988 | 0 | 12,066 | 953,690 | 303,100 | 15,210 | 1,284,066 | 0 | 37,465 | 185,074 | 111,593 | 2,832 | 336,964 | 0 | 49,531 | 1,138,764 | 414,693 | 18,042 | 1,621,030 |
| 1989 | 0 | 19,500 | 426,001 | 109,566 | 0 | 555,067 | 0 | 6,612 | 193,305 | 48,886 | 328 | 249,131 | 0 | 26,112 | 619,306 | 158,452 | 328 | 804,199 |
| 1990 | 0 | 34,022 | 394,147 | 20,232 | 0 | 448,402 | 0 | 12,508 | 231,625 | 42,738 | 185 | 287,056 | 0 | 46,530 | 625,772 | 62,970 | 185 | 735,458 |
| 1991 | 0 | 37,736 | 19,998 | 0 | 0 | 57,734 | 0 | 28,013 | 52,292 | 4,383 | 0 | 84,688 | 0 | 65,749 | 72,291 | 4,383 | 0 | 142,422 |
| 1992 | 0 | 3,581 | 0 | 0 | 0 | 3,581 | 0 | 9,677 | 26,049 | 0 | 0 | 35,726 | 0 | 13,257 | 26,049 | 0 | 0 | 39,307 |
| 1993 | 0 | 2,169 | 0 | 0 | 0 | 2,169 | 0 | 37,849 | 0 | 0 | 0 | 37,849 | 0 | 40,018 | 0 | 0 | 0 | 40,018 |
| Total | 0 | 688,675 | 3,852,012 | 848,642 | 25,838 | 5,415,166 | 0 | 558,292 | 1,913,201 | 382,677 | 5,793 | 2,859,962 | 0 | 1,246,967 | 5,765,212 | 1,231,319 | 31,630 | 8,275,128 |
| Tot.77-91 | 0 | 682,925 | 3,852,012 | 848,642 | 25,838 | 5,409,417 | 0 | 510,766 | 1,887,151 | 382,677 | 5,793 | 2,786,387 | 0 | 1,193,691 | 5,739,163 | 1,231,319 | 31,630 | 8,195,804 |

Appendix 1 (con't) Contribution of Inner South Coast enhanced stocks by brood year by age by facility to catch and escapement.

**Fraser Enhanced Stocks (Chilliwack, Chehalis, Blaney, Inch, Stave)**

| | Catch at Age | | | | | | Escapement at Age | | | | | | Catch + Escapement at Age | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Br.Yr. | 2 | 3 | 4 | 5 | 6 | Total | 2 | 3 | 4 | 5 | 6 | Total | 2 | 3 | 4 | 5 | 6 | Total |
| 1977 | 0 | 2,766 | 310 | 356 | 0 | 3,433 | 2 | 2,492 | 4,017 | 353 | 0 | 6,864 | 2 | 5,258 | 4,327 | 709 | 0 | 10,297 |
| 1978 | 0 | 1 | 1,167 | 5 | 0 | 1,173 | 0 | 1,167 | 3,143 | 90 | 0 | 4,400 | 0 | 1,168 | 4,310 | 95 | 0 | 5,573 |
| 1979 | 0 | 707 | 57 | 0 | 0 | 765 | 0 | 3,358 | 2,546 | 59 | 0 | 5,963 | 0 | 4,065 | 2,603 | 59 | 0 | 6,728 |
| 1980 | 0 | 0 | 1,864 | 0 | 0 | 1,864 | 0 | 3,248 | 1,954 | 37 | 0 | 5,239 | 0 | 3,248 | 3,818 | 37 | 0 | 7,103 |
| 1981 | 0 | 1,829 | 9,696 | 5,050 | 0 | 16,575 | 0 | 7,675 | 44,387 | 1,733 | 0 | 53,795 | 0 | 9,504 | 54,083 | 6,783 | 0 | 70,370 |
| 1982 | 0 | 18,282 | 116,758 | 3,268 | 250 | 138,559 | 0 | 112,602 | 211,215 | 14,551 | 106 | 338,474 | 0 | 130,884 | 327,973 | 17,819 | 356 | 477,033 |
| 1983 | 0 | 3,800 | 3,798 | 4,136 | 13 | 11,748 | 0 | 6,492 | 51,191 | 4,907 | 0 | 62,590 | 0 | 10,292 | 54,989 | 9,043 | 13 | 74,338 |
| 1984 | 0 | 867 | 162,527 | 12,357 | 146 | 175,897 | 0 | 15,468 | 104,686 | 10,227 | 119 | 130,500 | 0 | 16,335 | 267,213 | 22,584 | 265 | 306,397 |
| 1985 | 0 | 44,488 | 67,799 | 3,451 | 0 | 115,737 | 0 | 54,553 | 169,961 | 5,562 | 0 | 230,076 | 0 | 99,041 | 237,760 | 9,013 | 0 | 345,813 |
| 1986 | 0 | 12,982 | 140,953 | 17,252 | 129 | 171,315 | 0 | 45,261 | 202,872 | 65,560 | 640 | 314,333 | 0 | 58,243 | 343,825 | 82,812 | 769 | 485,648 |
| 1987 | 0 | 2,004 | 23,336 | 12,247 | 0 | 37,588 | 0 | 1,735 | 87,549 | 11,410 | 78 | 100,772 | 0 | 3,739 | 110,885 | 23,657 | 78 | 138,360 |
| 1988 | 0 | 876 | 104,660 | 15,648 | 138 | 121,322 | 0 | 33,769 | 139,169 | 18,558 | 320 | 191,816 | 0 | 34,645 | 243,829 | 34,206 | 458 | 313,138 |
| 1989 | 0 | 13,442 | 110,879 | 15,663 | 196 | 140,180 | 0 | 30,749 | 232,972 | 20,168 | 121 | 284,010 | 0 | 44,191 | 343,851 | 35,831 | 318 | 424,190 |
| 1990 | 0 | 13,821 | 90,813 | 9,186 | 0 | 113,820 | 0 | 20,071 | 136,770 | 28,484 | 260 | 185,585 | 0 | 33,892 | 227,583 | 37,670 | 260 | 299,405 |
| 1991 | 0 | 15,302 | 25,407 | 548 | 0 | 41,257 | 0 | 16,493 | 61,988 | 9,561 | 0 | 88,042 | 0 | 31,795 | 87,395 | 10,109 | 0 | 129,299 |
| 1992 | 0 | 3,093 | 2,381 | 0 | 0 | 5,475 | 0 | 10,430 | 40,675 | 0 | 0 | 51,105 | 0 | 13,523 | 43,057 | 0 | 0 | 56,580 |
| 1993 | 0 | 1,220 | 0 | 0 | 0 | 1,220 | 0 | 84,396 | 0 | 0 | 0 | 84,396 | 0 | 85,616 | 0 | 0 | 0 | 85,616 |
| Total | 0 | 135,481 | 862,406 | 99,167 | 873 | 1,097,927 | 2 | 449,959 | 1,495,095 | 191,261 | 1,644 | 2,137,960 | 2 | 585,439 | 2,357,501 | 290,427 | 2,517 | 3,235,887 |
| Tot.77-91 | 0 | 131,167 | 860,025 | 99,167 | 873 | 1,091,232 | 2 | 355,133 | 1,454,420 | 191,261 | 1,644 | 2,002,459 | 2 | 486,300 | 2,314,445 | 290,427 | 2,517 | 3,093,691 |

Appendix 1 (con't) Contribution of Inner South Coast enhanced stocks by brood year by age by facility to catch and escapement.

**Inner South Coast Enhanced Stocks (Puntledge, Big & Little Qualicum, Chilliwack, Chehalis, Blaney, Inch, Stave)**

| | Catch at Age | | | | | | Escapement at Age | | | | | | Catch + Escapement at Age | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Br.Yr.** | **2** | **3** | **4** | **5** | **6** | **Total** | **2** | **3** | **4** | **5** | **6** | **Total** | **2** | **3** | **4** | **5** | **6** | **Total** |
| 1977 | 0 | 38,070 | 38,982 | 7,262 | 0 | 84,314 | 2 | 37,293 | 78,185 | 4,985 | 0 | 120,465 | 2 | 75,363 | 117,167 | 12,247 | 0 | 204,779 |
| 1978 | 0 | 6,271 | 152,869 | 12,505 | 0 | 171,645 | 0 | 13,193 | 104,893 | 13,556 | 0 | 131,642 | 0 | 19,464 | 257,762 | 26,061 | 0 | 303,287 |
| 1979 | 0 | 57,436 | 88,666 | 14,866 | 0 | 160,968 | 0 | 51,781 | 143,533 | 7,340 | 0 | 202,654 | 0 | 109,217 | 232,199 | 22,206 | 0 | 363,622 |
| 1980 | 0 | 10,682 | 70,936 | 3,505 | 0 | 85,123 | 0 | 29,130 | 51,731 | 37 | 0 | 80,898 | 0 | 39,812 | 122,667 | 3,542 | 0 | 166,021 |
| 1981 | 0 | 95,205 | 320,777 | 24,136 | 0 | 440,119 | 0 | 94,101 | 146,604 | 7,160 | 0 | 247,865 | 0 | 189,306 | 467,381 | 31,296 | 0 | 687,984 |
| 1982 | 0 | 289,904 | 628,134 | 38,762 | 2,399 | 959,199 | 0 | 284,404 | 478,742 | 49,234 | 1,993 | 814,373 | 0 | 574,308 | 1,106,876 | 87,996 | 4,392 | 1,773,572 |
| 1983 | 0 | 59,619 | 237,450 | 59,258 | 1,445 | 357,772 | 0 | 22,799 | 156,432 | 32,197 | 222 | 211,650 | 0 | 82,418 | 393,882 | 91,455 | 1,667 | 569,422 |
| 1984 | 0 | 9,261 | 295,411 | 47,553 | 238 | 352,464 | 0 | 18,298 | 207,578 | 37,848 | 119 | 263,843 | 0 | 27,559 | 502,989 | 85,401 | 357 | 616,307 |
| 1985 | 0 | 53,315 | 148,951 | 11,304 | 0 | 213,570 | 0 | 58,998 | 225,824 | 12,672 | 1 | 297,495 | 0 | 112,313 | 374,775 | 23,976 | 1 | 511,065 |
| 1986 | 0 | 42,189 | 445,490 | 159,281 | 5,062 | 652,021 | 0 | 67,080 | 346,084 | 103,763 | 977 | 517,904 | 0 | 109,269 | 791,574 | 263,044 | 6,039 | 1,169,925 |
| 1987 | 0 | 5,374 | 158,775 | 95,436 | 2,022 | 261,606 | 0 | 3,142 | 168,770 | 20,775 | 78 | 192,765 | 0 | 8,516 | 327,545 | 116,211 | 2,100 | 454,371 |
| 1988 | 0 | 12,941 | 1,058,351 | 318,748 | 15,348 | 1,405,388 | 0 | 71,234 | 324,243 | 130,151 | 3,152 | 528,780 | 0 | 84,175 | 1,382,594 | 448,899 | 18,500 | 1,934,168 |
| 1989 | 0 | 32,941 | 536,880 | 125,229 | 196 | 695,247 | 0 | 37,361 | 426,277 | 69,054 | 450 | 533,142 | 0 | 70,302 | 963,157 | 194,283 | 646 | 1,228,389 |
| 1990 | 0 | 47,844 | 484,960 | 29,418 | 0 | 562,222 | 0 | 32,579 | 368,395 | 71,222 | 445 | 472,641 | 0 | 80,423 | 853,355 | 100,640 | 445 | 1,034,863 |
| 1991 | 0 | 53,038 | 45,405 | 548 | 0 | 98,992 | 0 | 44,506 | 114,280 | 13,944 | 0 | 172,730 | 0 | 97,544 | 159,685 | 14,492 | 0 | 271,721 |
| 1992 | 0 | 6,674 | 2,381 | 0 | 0 | 9,056 | 0 | 20,106 | 66,724 | 0 | 0 | 86,831 | 0 | 26,780 | 69,106 | 0 | 0 | 95,886 |
| 1993 | 0 | 3,389 | 0 | 0 | 0 | 3,389 | 0 | 122,245 | 0 | 0 | 0 | 122,245 | 0 | 125,634 | 0 | 0 | 0 | 125,634 |
| Total | 0 | 824,156 | 4,714,418 | 947,809 | 26,711 | 6,513,093 | 2 | 1,008,250 | 3,408,295 | 573,938 | 7,437 | 4,997,922 | 2 | 1,832,406 | 8,122,714 | 1,521,747 | 34,147 | 11,511,015 |
| Tot.77-91 | 0 | 814,093 | 4,712,037 | 947,809 | 26,711 | 6,500,649 | 2 | 865,899 | 3,341,571 | 573,938 | 7,437 | 4,788,846 | 2 | 1,679,992 | 8,053,608 | 1,521,747 | 34,147 | 11,289,495 |

Appendix 2. 80% and 95% Bootstrap Confidence limits for Ricker Parameters.

Bootstrap statistics for Fraser River chum salmon

| Variable | Reps | Observed | Bias | Std. Err. | [80% Conf. Interval] | | |
|---|---|---|---|---|---|---|---|
| OptimalH | 1000 | .4549801 | -.0121472 | .0623524 | .3750194 | .5349408 | (N) |
| | | | | | .3616587 | .5189448 | (P) |
| | | | | | .3857566 | .5349245 | (BC) |
| rickera | 1000 | 1.070352 | -.0283757 | .1755477 | .8452293 | 1.295474 | (N) |
| | | | | | .8166965 | 1.260237 | (P) |
| | | | | | .8799061 | 1.310163 | (BC) |
| rickerb | 1000 | 1737787 | -199911.8 | 2.83e+07 | -3.45e+07 | 3.80e+07 | (N) |
| | | | | | 1120830 | 4803063 | (P) |
| | | | | | 1154187 | 5634560 | (BC) |
| Smsy | 1000 | 738690.3 | -87299.45 | 1.24e+07 | -1.52e+07 | 1.66e+07 | (N) |
| | | | | | 459301.6 | 2092178 | (P) |
| | | | | | 479080 | 2481638 | (BC) |
| Smax | 1000 | 1623566 | -212837.3 | 3.22e+07 | -3.97e+07 | 4.29e+07 | (N) |
| | | | | | 853276.8 | 5201239 | (P) |
| | | | | | 913186.5 | 6304125 | (BC) |
| Rmax | 1000 | 1741900 | -195009.9 | 2.85e+07 | -3.48e+07 | 3.83e+07 | (N) |
| | | | | | 1140995 | 4825827 | (P) |
| | | | | | 1168168 | 5227287 | (BC) |
| MsySmsy | 1000 | 1366831 | -142497.4 | 2.03e+07 | -2.47e+07 | 2.75e+07 | (N) |
| | | | | | 909136.9 | 3574407 | (P) |
| | | | | | 942767.5 | 3874547 | (BC) |

N = normal, P = percentile, BC = bias corrected

Bootstrap statistics for Fraser River chum salmon

| Variable | Reps | Observed | Bias | Std. Err. | [95% Conf. Interval] | | |
|---|---|---|---|---|---|---|---|
| OptimalH | 1000 | .4549801 | -.0111754 | .0606369 | .3359899 | .5739704 | (N) |
| | | | | | .3187582 | .5584596 | (P) |
| | | | | | .3383276 | .5682237 | (BC) |
| rickera | 1000 | 1.070352 | -.0259185 | .1713422 | .7341198 | 1.406583 | (N) |
| | | | | | .7076176 | 1.385772 | (P) |
| | | | | | .7568502 | 1.417915 | (BC) |
| rickerb | 1000 | 1737787 | 3789289 | 1.07e+08 | -2.08e+08 | 2.11e+08 | (N) |
| | | | | | -1.12e+07 | 1.99e+07 | (P) |
| | | | | | -8918146 | 2.70e+07 | (BC) |
| Smsy | 1000 | 738690.3 | 1646833 | 4.62e+07 | -8.99e+07 | 9.14e+07 | (N) |
| | | | | | -4929750 | 8871265 | (P) |
| | | | | | -3889967 | 1.20e+07 | (BC) |
| Smax | 1000 | 1623566 | 4088124 | 1.11e+08 | -2.16e+08 | 2.20e+08 | (N) |
| | | | | | -1.40e+07 | 2.67e+07 | (P) |
| | | | | | -1.15e+07 | 3.25e+07 | (BC) |
| Rmax | 1000 | 1741900 | 3814411 | 1.07e+08 | -2.08e+08 | 2.11e+08 | (N) |
| | | | | | -1.13e+07 | 2.08e+07 | (P) |
| | | | | | -9295692 | 2.55e+07 | (BC) |
| MsySmsy | 1000 | 1366831 | 2797519 | 7.97e+07 | -1.55e+08 | 1.58e+08 | (N) |
| | | | | | -7625718 | 1.36e+07 | (P) |
| | | | | | -7180628 | 1.53e+07 | (BC) |

N = normal, P = percentile, BC = bias corrected

Bootstrap statistics for Clockwork wild chum salmon.

| Variable | Reps | Observed | Bias | Std. Err. | [80% Conf. Interval] | | |
|---|---|---|---|---|---|---|---|
| OptimalH | 1000 | .4352859 | -.0202798 | .101778 | .3047658 | .565806 | (N) |
| | | | | | .2786603 | .5341458 | (P) |
| | | | | | .2893046 | .5422705 | (BC) |
| rickera | 1000 | 1.014725 | -.0415576 | .2748791 | .6622204 | 1.36723 | (N) |
| | | | | | .6092941 | 1.307704 | (P) |
| | | | | | .6350737 | 1.333487 | (BC) |
| rickerb | 1000 | 2659544 | -1788173 | 8.06e+07 | -1.01e+08 | 1.06e+08 | (N) |
| | | | | | 1706945 | 5960297 | (P) |
| | | | | | 1970618 | 9265719 | (BC) |
| Smsy | 1000 | 1140863 | -808257.4 | 3.66e+07 | -4.58e+07 | 4.81e+07 | (N) |
| | | | | | 696054.4 | 2649921 | (P) |
| | | | | | 812001.1 | 4212481 | (BC) |
| Smax | 1000 | 2620950 | -2645280 | 1.24e+08 | -1.56e+08 | 1.61e+08 | (N) |
| | | | | | 1122802 | 7864144 | (P) |
| | | | | | 1552659 | 1.40e+07 | (BC) |
| Rmax | 1000 | 2659830 | -1909188 | 8.74e+07 | -1.09e+08 | 1.15e+08 | (N) |
| | | | | | 1730178 | 6193497 | (P) |
| | | | | | 1987808 | 8996702 | (BC) |
| MsySmsy | 1000 | 2036482 | -1168018 | 5.23e+07 | -6.50e+07 | 6.91e+07 | (N) |
| | | | | | 1380526 | 4006734 | (P) |
| | | | | | 1479129 | 4551206 | (BC) |

N = normal, P = percentile, BC = bias corrected

Bootstrap statistics Wild Clockwork Chum Salmon

| Variable | Reps | Observed | Bias | Std. Err. | [95% Conf. Interval] | | |
|---|---|---|---|---|---|---|---|
| OptimalH | 1000 | .4352859 | -.0164635 | .0964149 | .246087 | .6244848 | (N) |
| | | | | | .1904065 | .574699 | (P) |
| | | | | | .2017107 | .5803051 | (BC) |
| rickera | 1000 | 1.014725 | -.0324458 | .2613436 | .5018798 | 1.527571 | (N) |
| | | | | | .4036203 | 1.439501 | (P) |
| | | | | | .4292128 | 1.458367 | (BC) |
| rickerb | 1000 | 2659544 | 979964.5 | 2.51e+07 | -4.66e+07 | 5.19e+07 | (N) |
| | | | | | -1.03e+07 | 1.40e+07 | (P) |
| | | | | | -3783315 | 4.57e+07 | (BC) |
| Smsy | 1000 | 1140863 | 452894.9 | 1.14e+07 | -2.13e+07 | 2.36e+07 | (N) |
| | | | | | -4773016 | 6430002 | (P) |
| | | | | | -1650017 | 2.69e+07 | (BC) |
| Smax | 1000 | 2620950 | 1814723 | 4.07e+07 | -7.72e+07 | 8.24e+07 | (N) |
| | | | | | -1.85e+07 | 2.21e+07 | (P) |
| | | | | | -7417545 | 8.53e+07 | (BC) |
| Rmax | 1000 | 2659830 | 1155487 | 2.78e+07 | -5.19e+07 | 5.72e+07 | (N) |
| | | | | | -1.16e+07 | 1.57e+07 | (P) |
| | | | | | -5605923 | 4.59e+07 | (BC) |
| MsySmsy | 1000 | 2036482 | 615245.3 | 1.62e+07 | -2.98e+07 | 3.39e+07 | (N) |
| | | | | | -6266749 | 9351173 | (P) |
| | | | | | -4164947 | 1.93e+07 | (BC) |

N = normal, P = percentile, BC = bias corrected