Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 99/133
Not to be cited without
permission of the authors[1]

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 99/133
Ne pas citer sans
autorisation des auteurs[1]

Status of coho salmon stocks adjacent to the Strait of Georgia, including the lower Fraser River

Kent Simpson[1], Rick Semple[2], Steve Baillie[1], Brenda Adkins[1] and Susan Lehmann[3]

[1] Stock Assessment Division, Science Branch
Pacific Biological Station
Nanaimo, BC V9R 5K6

[2] Stock Assessment Division, Science Branch
3-100 Annacis Parkway
Delta, BC V3M 6A2

[3] Program Co-ordination and Assessment Division
Habitat and Enhancement Branch
555 W. Hastings St.
Vancouver, BC V6B 5G3

ISSN 1480-4883
Ottawa, 1999
Canada

Abstract

Lower Fraser and Vancouver Island indicators continue to show different patterns of ocean survival, escapements and possibly smolt production. There is insufficient information to define the situation on the Sunshine Coast/Howe Sound. Escapements in 1997 were improved but still well below recent averages and this was reflected in below average fry densities in 1998. Probably due to dry summer conditions, the fry were not correspondingly large and smolt numbers may be low again this spring. Smolt runs on Vancouver Island were probably below average to well below average in 1998. Coupled with a forecast of continued poor ocean survival (Working Paper S99-2) the abundance of adult coho from the east coast of Vancouver Island is expected to be very poor in 1999.

Although there is some evidence for reduced recruitment to the ocean, it is clear that continuing poor ocean survivals are driving the low abundances. 1997 and 1998 were the third and fourth consecutive years of 'outside' distribution by Georgia Basin coho. The survival of coho in the northern Basin stabilised in 1995-96 while survivals of middle and southern Basin stocks continued to decline. Survivals, although poor, are now better at the north end than to the south. This was apparent in the 1998 escapements. Spawner numbers were probably adequate in SE Vancouver Island and on the Lower Mainland but they have responded sluggishly to the near cessation of exploitation. In the Lower Mainland, both smolts and adults have been relative stable over the last four years, based on two wild coho monitoring projects. This stabilisation of smolts and adults in one of the indicator stocks, Salmon River (Langley), is at a level much below that seen in the 1980's. Recent declines in survival of Salmon coho up to 1998 appeared as lower exploitations/catches rather than reduced escapements, which we cannot explain. The 1998 escapement to both streams actually declined despite the virtual cessation of fishing, another signal that abundances of some Lower Mainland stocks are very low.

Survivals of hatchery coho, normally not as good as wild survivals, were again poorer in 1997 and 1998, putting them at critically low levels in 1998 of only 0.3 to 1.0 percent. These survival estimates do not include ventral clipped releases which survived on average 38% more poorly.

There are conflicting signals coming from the Lower Mainland data and another wild indicator stock project would be helpful. A wild indicator further north on the mainland remains a pressing need. The fry survey as conducted in the Basin now appears to be useful in estimating parental escapements, at least at low escapement levels. Its economy allows us to survey more streams than other techniques. Fry data will aid us in defining the sample needed to accurately monitor stocks in the Lower Mainland and throughout the Basin.

Résumé

Les indicateurs du bas Fraser et de l'Île de Vancouver continuent de présenter des allures variables en ce qui a trait à la survie en mer, aux échappées et peut-être à la production de saumoneaux. En raison du manque d'information il est impossible de définir la situation dans la région de la Sunshine Coast et de la baie Howe. Il y a eu amélioration des échappées en 1997, mais celles-ci demeurent largement sous les moyennes récentes, ce qui s'est traduit, en 1998, par des densités d'alevins inférieures à la moyenne. Les conditions sèches de l'été ont sans doute influé sur la taille des alevins, qui était faible, et le nombre de saumoneaux pourrait être faible encore ce printemps. Les descentes de saumoneaux dans l'île de Vancouver ont probablement été d'inférieures à largement inférieures à la moyenne en 1998. Aux prévisions du maintien d'une faible survie en mer (document de travail S99-2), s'ajoute celle d'une très faible abondance, en 1999, des saumons coho adultes de la côte est de l'île de Vancouver.

Bien que des indices témoignent d'une baisse du recrutement en mer, il ne fait aucun doute que c'est la persistance d'une piètre survie en mer qui est le facteur déterminant de la faible abondance. Les années 1997 et 1998 étaient les troisième et quatrième années consécutives de distribution extérieure du saumon coho du bassin Georgia. La survie du coho au nord du bassin s'est stabilisée en 1995-1996, tandis que celle des stocks au centre et au sud a continué de décliner. Bien que faible, la survie au nord est maintenant meilleure qu'au sud du bassin, et cela a été démontré par les échappées de 1998. Le nombre de géniteurs était probablement suffisant au sud-est de l'île de Vancouver et le Lower Mainland, mais il est demeuré stagnant en dépit de la quasi-cessation de l'exploitation. Les deux projets de dénombrement des saumons coho sauvages ont montré que le nombre de saumoneaux et d'adultes dans le Lower Mainland est demeuré plutôt stable au cours des quatre dernières années. En revanche, le nombre de saumoneaux et d'adultes d'un des stocks indicateur, de la rivière Salmon (Langley) s'est stabilisé à un niveau très inférieur à ceux des années 1980. Le déclin récent de la survie du saumon coho jusqu'en 1998 s'est manifesté par une réduction de l'exploitation et des captures plutôt que par une diminution des échappées, ce que nous n'arrivons pas à expliquer. Les échappées vers ces deux cours d'eau ont en fait diminué en 1998 en dépit de la cessation virtuelle de la pêche, un autre signal que certains stocks du Lower Mainland sont très bas.

La survie du coho d'élevage, normalement plus faible que celle du coho sauvage, a diminué encore en 1997 et en 1998, atteignant les taux critiques de 0,3 à 1,0 % en 1998. Ces estimations ne tiennent pas compte des sujets relâchés auxquels on a rogné une nageoire pelvienne et dont le taux moyen de survie est de 38 % inférieur aux autres.

Les données en provenance du Lower Mainland sont contradictoires, et un nouveau projet de stock indicateur sauvage pourrait être utile. Il y a un besoin pressant de disposer d'un stock indicateur sauvage plus au nord sur le continent. Le relevé des alevins effectué dans le bassin Georgia apparaît désormais comme un moyen utile d'estimer les échappées des géniteurs, du moins lorsque celles-ci sont peu importantes. Grâce à son coût peu élevé, cette technique permet d'augmenter le nombre de cours d'eau évalués. Les données sur les alevins nous aideront à établir l'échantillon nécessaire pour suivre de façon précise l'évolution des stocks dans le Lower Mainland et tout le bassin.

1 INTRODUCTION

This is the sixth PSARC Working Paper presenting an assessment of the coho populations in the Georgia Basin and provides 1997 and 1998 data to update the last report (Simpson et al. 1997). The assessment information includes juvenile abundance data, catches by fishing sector and location, escapements, survival rates and exploitation rates. Unlike the last report, we do not discuss coho stocks in the Thompson and upper Fraser drainages. We define 'Georgia Basin' for this report as Canadian drainages emptying into the Strait of Georgia, including the Fraser system as far upstream as Hope. An accompanying paper will present data for other Fraser coho stocks (Irvine et al. 1999). Forecasts of the 1999 marine survival, abundance and distribution of southern BC coho have been submitted (Holtby et al. 1999).

2 METHODS

Assessment of coho from the Georgia Basin relies on using some stocks to represent other stocks in the same area (e.g. Symons and Waldichuk 1984). These 'indicator' stocks include all wild and most hatchery stocks that have reliable smolt release, catch and escapement data. The catch distributions of coded wire tagged (CWT'd) coho from 1990 to 1993 were analysed by cluster analysis in Kadowaki et al. (1995) to define stock aggregates that may be associated with indicator stocks. Melding the cluster analysis results with criteria of geographic proximity and biogeography yielded stock aggregates representing seven regions: SE Vancouver Island, Nanaimo area, Baynes Sd., Campbell River area, Powell River area, Sunshine Coast/Squamish/North Shore, and lower Fraser. Based on the between-stream covariations that can be seen in the data summarised in this report and from earlier work (e.g. Labelle 1990a), marine mortality factors appear to be sufficiently similar between stocks in a region to permit the indicator stock strategy to be a valid practical solution to the high cost of obtaining extensive survival and exploitation rate data.

The interpretation of data obtained from indicator stocks is supplemented with extensive assessments of fry densities, which can be obtained relatively cheaply. Although not as readily obtained, we are also trying to estimate more escapements, for example with the help of volunteers and special funding programs. The stocks discussed below in Sections 2.1 and 2.2 are only the nodes of our network of heightened accuracy data: what we refer to as 'indicator' stocks as opposed to sources of 'extensive' escapement and fry data which are usually of lesser accuracy.

2.1 Wild Indicator Stocks

Black Creek and Salmon River (Langley) are the only wild populations where we have the smolt, catch and escapement data needed to estimate survival and exploitation rates. The Mesachie Creek indicator operation ended in 1996. There is a time series of medium quality estimates of coho escapements from a suite of Cowichan River tributaries and from upper Pitt River. All other indicators with what we characterise as 'intensive' data sets are hatchery stocks or enhanced streams, e.g. Chase River in Nanaimo.

2.1.1 Black Creek

This creek flows into the Strait of Georgia mid-way between Courtenay and Campbell River and is a mid-sized, low gradient stream, 31 km long (Brown et al. 1996). It is the site of the longest and most complete time series of wild coho data in the Georgia Basin.

There was an adult counting fence near tidewater for six years between 1968 and 1980 and every year since 1985 (Kadowaki et al. 1995). Of the pre-1980 counts, 1975 and 1978 are considered the most accurate and are the only escapements used from this period in this report. However, the 1975 escapement may be an underestimate (the

escapement includes an estimate of 450 uncounted coho during a two-day breach and the fence was also terminated early). Escapements from 1985 to 1995 were estimated using mark recapture (MR) analyses of coho tagged at the fence. However, a large proportion of the spawners were counted at the fence in most years: the MR estimate was less than 10% greater than the fence count of adults in 1986, 1987, 1992, 1993, and 1995. Only the 1985, 1997 and 1998 fence counts were less than half the MR estimate. The 1996 adult count was barely more than half the MR estimate (147/283). Fence counts have been particularly difficult in the last three years because of record rainfalls.

We have fence counts of smolts in 1978 and 1979 and for every year since 1985. The fences caught virtually all smolts during their operation in most years. The median expansion multiplier of the fence count to obtain the estimated smolt numbers used in this report was 1.03. The proportion of tagged adults in 1985 was about half the proportion of smolts that were thought to have been tagged. Labelle (1990b) thought the most likely explanation was that the actual number of smolts was about double the original estimate. However, the proportion of tagged adults was also low in 1996, 1997 and 1998: 64.2%, 19.6% and 40.5%. Although adult runs in 1996 and 1997 were small enough that it is conceivable that enough of them were missed as smolts to produce the untagged rates, there were fully 4,531 untagged adults estimated in 1998 – too many to be readily explained this way. Other possible reasons need to be examined, in particular the possibility that significant straying is occurring into Black Creek, perhaps from Oyster River nearby. For now, we will present smolt numbers not corrected for adult mark rate. This uncertainty does not affect estimates of marine survival and exploitation since only tagged coho are used in the calculations.

Black Creek smolt and adult assessments up to the spring of 1995 are published: Clarke and Irvine (1989), Fielden et al. (1989), Labelle (1990a), Bocking et al. (1991, 1992), Nass et al. (1993a,b), Nelson et al. (1994a,b, 1995, 1996), and Nelson and Simpson (1996).

2.1.2 Salmon River (Langley)

Salmon River is a lowland tributary that flows northeast for 33 km before it enters the Fraser River near Fort Langley. It is one of several streams called Salmon River in British Columbia. 'Salmon River' in this report always refers to this stream. Its principal tributary, Coghlan Creek, joins the mainstem 14 km upstream from the Fraser River. The Salmon River supports the largest coho population of any of the wild stock indicators.

Escapement estimates provided by fishery officers are available from 1951 to 1987 (Farwell et al. 1987; unpublished files). We have little confidence in the accuracy of these estimates because visual counts are difficult and the estimation procedures were not documented. These data, therefore, will not be presented here.

During 1977-1981, escapement was monitored using systematic foot surveys (Schubert 1982b; Schubert and Fleming 1989); however, estimations of accuracy and precision were largely inadequate. In 1982 and 1986, traps were installed in culverts where the river passes under the dike at the river mouth (Schubert and Fleming 1989). This technique proved unsuitable because the traps could not fish during high flows.

Furthermore, tagging data showed that fish from nearby stocks would enter the trap and subsequently leave the Salmon River when the traps were removed during freshets.

Since 1987, escapement has been estimated using the single census Petersen MR technique. From 1987 to 1996, coho adults were captured using an electroshocker and marked with disk tags and opercular punches. Starting in 1997 and 1998 a fence installed 5 km from the mouth was used to capture fish for this purpose. The fence by itself was not thought to be able to capture all coho because of possible high water events which could pass fish by the structure without being counted; hence, our continued reliance on mark and recapture as a means of estimating the escapement. Escapements are estimated by the recovery and examination of carcasses for marked and unmarked coho following spawning (e.g. Schubert et al. 1994a).

Smolt traps were operated in the Salmon River and in Coghlan Creek during the springs of 1978-1980 (Schubert 1982a) and 1986-1998 (Schubert and Kalnin 1990; Farwell et al. 1991; 1992a,b; Kalnin and Schubert 1991; Schubert et al. 1994a,b; R. Diewert and R. Semple, unpubl. data). Up to 1997, the Coghlan and Salmon traps, which were located in Williams Park, 14 km from the mouth, were designed solely to capture coho smolts for coded wire tag application. In 1998, they were used to capture smolts to mark (Panjet dye and/or a fin clip) as part of a Petersen population estimate. Mark recovery took place at the new fence in the lower Salmon River, where smolts were also coded wire tagged. None of the smolt fence installations provide estimates of total smolt production because the trapping period did not encompass the entire emigration period, nor could the traps be operated during high flows. Smolt production from the river downstream of the traps was not directly assessed in any year. In the case of the lower Salmon fence, this may not be important because we feel that all of the fry production comes from upstream habitat. However, it is possible that smolts are over-wintering in the 5 km below the fence (or even elsewhere in the lower Fraser).

To index smolt trends, we used a smolt production index (SPI, Schubert et al. 1994a). The index represents Petersen estimates, scaled by a factor of 10^{-5}, using fin clipped smolts as the mark application sample and adult recoveries as the census sample. The estimates are expressed as an index because capture and tagging probably reduced smolt to adult survival, introducing an unknown positive bias in the population estimates. However, the bias is presumably similar among years.

2.1.3 Upper Pitt River

The upper Pitt River originates in Garibaldi Provincial Park near Isosceles Peak (1710 m) and flows 52 km in a southerly direction to the north end of Pitt Lake. The lower Pitt River drains Pitt Lake and enters the north side of the Fraser River near Coquitlam. The upper Pitt River flows for most of its length in a braided, shifting channel through a 1 km wide U-shaped valley. The river has a relatively high rate of bed-load transport and an overall gradient of 3.2% (Elson 1985). Tributaries enter the upper Pitt River mainstem from steep valleys and have short, flat, delta areas in the river's floodplain.

The hydrograph of the upper Pitt River reflects a dominant summer glacial melt with low flows from December to March. Daily river discharges vary widely in the fall due to frequent heavy rainfalls and freezing and thawing temperatures. Extreme autumn discharges often result in scouring and shifts in the main river channel (Elson 1985).

Coho salmon enter the upper Pitt River system as early as September and begin to spawn in mid-November. There are no obstructions to adult migration for the lower 40 km of the river but adults usually concentrate in an area half that length (Elson 1985). The main run of adults usually remains in the upper Pitt mainstem through December with peak spawning occurring later that month. A second group of coho may arrive in the river in late January and spawn in early February (Schubert 1982b). Coho spawning is generally confined to side channels and the lower 2 km of tributaries.

Escapement estimates provided by fishery officers are available from 1951 to 1996 (Schubert and Fedorenko 1985; unpublished files). We have little confidence in the accuracy of these estimates because river conditions often made enumeration difficult, and the estimation procedures were not documented. These data, therefore, will not be presented here.

Systematic spawning ground surveys were carried out from 1977 to 1981 and in 1983 (Schubert 1982b, Schubert and Fleming 1989). Escapement estimates were derived subjectively based on live and dead counts in conjunction with sighting conditions, physical stream characteristics and carcass flushing rates.

In 1982, and from 1994 to 1998, escapement has been estimated using the Petersen MR technique (Schubert and Fleming 1989; R. Diewert and R. Semple unpubl. data). Coho adults were captured mainly by beach seine in the lower reaches of the mainstem upper Pitt River and marked with uniquely numbered disk tags and opercular punches. Tributary spawning grounds were surveyed throughout the spawning period and the incidence of disk tagged carcasses was used to estimate the total spawning escapement.

2.1.4 Cowichan River System

The Cowichan River drains Cowichan Lake and flows east for 50 km to Duncan and Cowichan Bay. It is a large system for Vancouver Island, draining 842 km². Its mean annual discharge is about 44 m³/sec (Armstrong and Argue 1977). It was recognised as one of the seven most important coho systems in the province (Aro and Shepard 1967) and is still a large producer (mean 1990-97 escapement of 10,500; see also Holtby, 1993).

The Fisheries Research Board of Canada operated a hatchery and adult counting fence from 1938 to 1944 on Oliver Creek, which enters Cowichan River just below Cowichan Lake. They also surveyed several other creeks, including Mesachie Creek in four of those years. Holtby (1993) has reconstructed the probable Mesachie escapement so we have escapement information for both creeks in this period. Several other assessments have occurred since, most notably a CWT program in 1975 and 1976 (Armstrong and Argue 1977; Argue et al. 1979) and CWT recovery and escapement estimates from 1976 to 1979 (Lister et al. 1981). Mesachie Creek was a full indicator stream with an upstream/downstream fence from 1986 to 1996 and is described by Holtby (1993).

Area-under-the-curve (AUC) estimates of coho escapements have been made in six or seven tributaries of the Cowichan River since 1989. The tributaries are: Mesachie Creek, Robertson River side channel, Patricia Creek and Shaw Creek (all of which are tributaries of Cowichan Lake); Oliver Creek at the outlet of Cowichan Lake; and Rotary Park side channel and Richards Creek which are in and near Duncan. All are wild to the

extent that no fry or smolt releases occur, although some fry salvaging has taken place in the past in some. The spawning habitat in Robertson and Rotary side channels has deteriorated so much we no longer count coho there.

2.2 Hatchery and Enhanced Stock Indicators

Coded-wire tagged hatchery stocks provide much of the critical data for determining catch distribution, survival and exploitation rates. Hatchery stocks have been tagged since the late 1960's and thus have a long time series of data. Generally, hatchery coho do not survive as well as adjacent wild stocks, but their survival, exploitation rate and catch distribution pattern correlate well with wild stock patterns. Hatchery indicator information is valuable to supplement intensive wild indicator data within a year and to provide data before wild monitoring began in the mid-1980's.

Hatchery indicator stocks were chosen because they represent other stocks in their area and have complete escapement information. Data from hatcheries with absent or incomplete escapement data can only be used for catch distribution. Powell River (Lang Cr.) and Capilano River data were not used because they are summer run stocks and are not regarded as representative of other stocks in the region. Capilano also has a large unassessed sport and aboriginal fishery.

There are Strait of Georgia hatchery indicator stocks on both the East Coast of Vancouver Island and in the Lower Fraser but clearly there are regional gaps. We do not have a hatchery or wild indicator on the mainland coast of the Strait of Georgia north of the Fraser River (GSMN). Tenderfoot Hatchery (Squamish R. system) may be used in future assessments. Its data must be reviewed and incorporated into the analysis if desirable. There is also potential for Goldstream River, on the southern end of Vancouver Island to be developed as an indicator. This stock has been tagged since the 1996 brood and an enumeration fence constructed.

2.2.1 East Coast Vancouver Island Stocks

Big Qualicum: The Big Qualicum River is 11 km long and runs from Horne Lake into the Strait of Georgia, 60 km north of Nanaimo. The Big Qualicum Project was the first of the modern enhancement projects to be undertaken in British Columbia. The project consists of a counting fence, chum spawning channels, incubation and rearing facilities for chinook, coho, steelhead and cutthroat, and complete flow control of the river.

Big Qualicum provides the longest time series of data for Strait of Georgia coho marine survival and exploitation rate trends. This stock is used as an indicator of survival trends and distribution for mid-Vancouver Island and Sunshine Coast coho stocks. Smolt releases have been consistently marked since the 1969 brood with coded-wire tags. Returning adults and jacks are enumerated and sampled for marks at the counting fence, located approximately one km from the estuary. Some fish are placed above the fence after sampling and allowed to spawn naturally. Less than 5% of the returns are estimated to spawn below the fence. These fish are not sampled for marks.

The 1995 brood coho were mass marked with a pelvic clip. The 1996 brood was mass marked with an adipose clip. In both years, tagging levels were doubled. For 1995 brood, 40k coho were tagged and marked with an adipose clip and 40k were tagged and marked with an adipose-left pelvic clip. For 1996 brood, 40k were tagged and marked with an adipose clip (Ad-CWT) and 40k were tagged but not clipped (CWT-only). Comparison of the different groups will help to determine survival rate differences due to clipping and the effects, if any, of any selective mass marked fisheries. In 1998, freshwater sport fisheries in the Big Qualicum River were mark retention only fisheries.

Quinsam: The Quinsam River is a tributary of the Campbell River, which enters Discovery Passage in the town of Campbell River. The hatchery is located 3 km above the confluence of the Quinsam and Campbell Rivers, which is 3.5 km from the Campbell estuary. The project consists of a diversion fence and incubation and rearing facilities for coho, chinook, pink and steelhead.

Quinsam stock is used as an indicator of survival trends, exploitation rate and distribution for north Vancouver Island and Mainland Inlet coho stocks. Smolt releases have been consistently marked with coded-wire tags since 1974 brood. Returning adults and jacks are enumerated and sampled for marks at the diversion fence. Some fish are placed above the fence and allowed to spawn naturally. Wild migrants were marked for 1972 to 1976 and 1984 to 1985 broods. Five to ten percent of the returns are estimated to spawn naturally below the fence. These fish are not sampled for marks. Additionally, some fish do pass above the fence unsampled, the number depending on flow conditions in the river. Attempts are made to quantify the unsampled number.

The 1995 brood Quinsam coho were not mass marked, due to disease concerns and the timing of the decision to mark. The 1996 brood was mass marked with an adipose clip. As for Big Qualicum, representative groups of Ad-CWT and CWT-only coho were released.

Chase River: This stream which enters the Nanaimo River estuary on the south side of Nanaimo is described by Irvine et al. 1994. It drains four regional district reservoirs and is about 11 km long; 4.5 km of which is accessible to coho and chum salmon. One salmon-bearing tributary enters the mainstem 2.8 km from the mouth. The range in

discharge is approximately 0.2 to 35 $m^3 \cdot sec^{-1}$. Most spawning occurs from the mouth to the tributary at 2.8 km.

The Malaspina University College Hatchery was built in 1985 and hatchery smolt releases began in 1987. Releases have ranged from 8,616 to 28,948 with no trend evident (Fig. 9). The mean release is 14,748. Coded wire tagged smolts were released from 1989 to 1997.

Spawner populations were estimated by mark-recapture from 1988 to 1995 and by AUC calculations using visual counts from 1990 to 1995 and in 1998. Malaspina University College made the estimates in conjunction with DFO (Irvine et al. 1994).

2.2.2 Lower Fraser River Stocks

Chilliwack: Chilliwack River flows northwest into Sumas River near the confluence with the Fraser River, near the town of Chilliwack. The hatchery is situated at Slesse Creek, approximately 35 km upstream from the mouth. It consists of a fishway and incubation and rearing facilities for coho, chum, chinook and steelhead. Enhancement began in 1980.

Coho have been released mainly as yearling smolts and have been tagged consistently from 1980 to the present. Hatchery returns are counted at the fishway and escapement estimates are made for several tributaries each year. A possibly substantial portion of the run is unaccounted for, due to a large freshwater sport fishery that has developed on the river. This fishery was not assessed between 1988 and 1998. Catch estimates were approximately 2,000, 15,000 and 15,000 in 1985, 1986 and 1988 respectively (Hickey et al. 1987, Whyte et al. 1987, Whyte and Schubert 1990), most of which were from Chilliwack Hatchery. The preliminary catch estimate for 1998 is 12,000 jack and adult coho (pers. comm. V. Palermo, DFO, 100 Annacis Parkway, Delta BC). Although the freshwater recreational catch is generally underestimated for a number of systems, the magnitude of the unassessed sport catches of Chilliwack Hatchery coho result in larger than average under-estimates of survival and exploitation rates for this indicator stock. Unless this fishery is assessed, Chilliwack cannot be used as an exploitation rate indicator but only as an indicator of survival trends and distribution.

The 1995 brood Chilliwack coho were mass marked with a pelvic clip, and the 1996 brood with an adipose clip. For the 1995 brood, both pelvic and adipose-pelvic groups of tagged fish were released. Application of 40k adipose-CWT had already occurred when the decision to mass mark was made. Therefore, an additional 40k Ad-CWT and 40k Ad-CWT-left pelvic were applied during the mass marking process, to ensure that comparisons could be made between the different groups of marks. The 1996 brood is represented by 40k Ad-CWT and 40k CWT-only. In 1998, freshwater sport fisheries in the Chilliwack River and most tributaries of the lower Fraser were mark retention only fisheries.

Inch: Inch Creek is a small groundwater-fed tributary of Nicomen Slough, near Dewdney. The hatchery is situated at the head of the creek and consists of incubation and rearing facilities for chum, coho, chinook, cutthroat and steelhead. Chum enhancement began in 1970 and coho were added in 1979. The hatchery enhances a number of coho stocks, including Norrish, Stave and Inch. Other stocks have also been enhanced in the past.

The Inch Creek coho stock has been released mainly as yearling smolts and has been

tagged consistently since 1982. Most of the coho return to the hatchery to spawn. Returns to the hatchery are enumerated and sampled for marks and a dead-pitch is conducted to enumerate and sample natural spawners. The creek is short and groundwater-fed, making conditions good for accurate enumeration and sampling. Typically, few marked fish are observed spawning in the river. Inch Creek is the best indicator for exploitation rates of lower Fraser stocks, since almost the entire return can be enumerated and sampled. Some concerns have been raised, however, as to how well this stock represents other lower Fraser stocks.

The 1995 brood Inch coho were mass marked with a pelvic clip. The 1996 brood was mass marked with an adipose clip. As at Big Qualicum, tagging levels were doubled for both years. For 1995 brood, 40k coho were tagged and marked with an adipose clip and 40k were tagged and marked with an adipose-left pelvic clip. For 1996 brood, 40k were tagged and marked with an adipose clip and 40k were tagged but not clipped. In 1998, freshwater sport fisheries on the three stocks enhanced at Inch Hatchery were open for marked and unmarked fish retention, unlike many other lower Fraser tributaries.

2.3 Catches and Coded-Wire Tag Recoveries

2.3.1 Catch

Recreational and commercial catch estimates are from the salmon stock assessment catch database (Catch Database Spreadsheet System ver 3.4) accessed through the ALPHA computer at PBS. Data for 1997 and 1998 are preliminary.

Recreational catch estimates in the Strait of Georgia up to 1976 were based on subjective assessments and local creel surveys. The statistics from 1972 to 1976 were revised by Argue et al. (1977) using CWT recoveries. The Strait of Georgia creel survey began in 1980 and continues. However, budget reductions have necessitated cuts to the period sampled, from 12 months/year up to 1992 to 9 months in 1993, 10 months in 1994, 8 months in 1995 and 6 months (April to September) in 1996 and 1997. April to September was covered in 1998 except in the Victoria area where the survey was extended to the end of October. Surveys before 1996 included October except in 1993. There has also been erosion in the number of fisher interviews during the survey period but not since at least 1996. Recreational catches are not estimated elsewhere except in the creel surveys in Barkley and Nootka sounds (incomplete temporal coverage) and in the lower Fraser mainstem. The lower Fraser survey was done in 1995 and 1996 but it was not designed for coho catch monitoring and usually terminated in September each year, before most returning coho were available in the river. Nor did this survey cover the intense local sport fishery directed at Chilliwack Hatchery coho in the Chilliwack/Vedder River although separate creel surveys have been conducted here in 1985-86, 1988 and 1998 as mentioned above. Clearly, south coast recreational catches of GS coho are under-estimated.

Most commercial catch is well estimated through the commercial sales slip system. However, the incidental catch of coho in commercial net fisheries are likely under-estimated due to ‘take home’ of coho and mis-reporting of coho on sales slips as other

species. Using observers, Bison (1992) estimated that the reported coho catch in the Nitinat chum fishery was one third of the actual catch.

Aboriginal catches of coho are not well recorded. Although possibly significant for local stocks, overall the aboriginal catch is a minor component of total recreational and commercial catch.

In 1998,because of serious conservation concerns for threatened wild coho stocks particularly those originating from the upper Skeena and Thompson rivers, special monitoring programs were implemented in all fisheries to ensure compliance with coho non-retention and non-possession regulations. The aim was to achieve zero fishing mortality for coho stocks from the upper Skeena and Thompson rivers (in red zones where these stocks are prevalent) and minimal risk of by-catch mortality for all other coho (in yellow zones where upper Skeena and Thompson coho stocks are not prevalent). The monitoring programs tracked and verified the reliability of coho encounter rates obtained by creel surveys in the Strait of Georgia and some west coast Vancouver Island recreational fisheries. There were on-board and roving observers from the end of July through September in the Strait and volunteer observers made direct observations on board sport charter vessels on the West Coast from about mid-July through mid-October. Moreover, catch monitoring of all southern BC commercial fisheries was initiated and consisted of on-board observers and mandatory logbooks (in the Johnstone Strait gillnet fishery) and hails. The overall goal of these programs was to avoid coho by-catch and reduce the mortality associated with catch and release, when coho were encountered.

2.3.2 Coded Wire Tag Recoveries

Coded wire tag recoveries were obtained from the MRP Reporter, version 3.9, accessed through the ALPHA computer at PBS. All recoveries were for ‘adults’ only, i.e. age .1 or brood year + 3 coho. Off-site hatchery releases were excluded. Estimated recoveries (observed recoveries multiplied by the catch:sample ratio) were used for wild stock analyses and expanded recoveries (estimated recoveries divided by the tagged proportion of the total hatchery release) were used for hatchery stocks. Estimated and not expanded recoveries were used for wild stocks because the numbers of unmarked smolts were unknown in wild stocks. Recoveries by catch region were not filtered to exclude strata with few recoveries where the sampling rate was low (causing a large number of recoveries to be estimated from a few recoveries with correspondingly large confidence limits on the estimate).

Each tag code release since the 1980 brood year is now flagged in the MRP database as being valid for survival, exploitation or distribution analyses. Only those codes flagged as suitable for exploitation and survival analyses were used. Hence there is more data available for distribution analyses than are shown in this report but the small data loss will not have affected the limited distribution analysis done here. All releases before the 1980 brood year were accepted if they were labelled as P (a production group) or B (an experimental group that can be considered as production). Earlier data are currently being updated to identify analysis type.

2.4 Fry Surveys

Data obtained from indicator stocks are supplemented and their interpretation evaluated using extensive annual assessments of fry and escapements. The rationale and general methods of the fry survey were presented by Kadowaki et al. (1995). Fry data are used in two ways in this report: to use extensive fry densities to assess the adequacy of our small sample of escapement time series in representing regional trends in escapement; and to use fry densities and sizes to qualitatively estimate the size of smolt runs in the region in 1998 and speculate on the same for 1999.

Streams were sampled in the early fall, one site per stream in about two thirds of the streams and usually two sites elsewhere. Streams were selected that were small enough to allow reaches to be isolated with nets, that had road access, and that had no enhancement (although some enhancement activities had been directed at some populations). We tried to sample the same sites each year although there have been some deletions and additions to the survey.

Site selection was not random: accessible reaches were selected that were judged to be coho habitat (we favoured lower gradient areas with pool and cover habitat). Although the fry survey methodology will be reviewed and some form of stratified random design may be deemed necessary for new analysis requirements, random selection has not been considered necessary for the first purpose of the data which is to aggregate densities to provide an index of inter-annual variations in abundance. This goal of detecting annual trends and perhaps discerning regional differences requires several years of data. The Georgia Basin fry survey began in 1991.

Most sampled reaches were 20 to 35 m long. The reach was isolated with barrier nets and the abundance of coho fry estimated using a removal technique (Seber and LeCren 1967), usually three pass with equal shocking and netting effort in each pass. The area and length of the reach was measured to calculate fry densities, with the area of water greater than 10 cm deep being recorded as well as total wetted area. Areas of riffles, glides and pools were also distinguished. The only other habitat measures taken were water temperature and since 1995, water conductivity. Calculated densities include age 1. or 2. fry which were usually less than 5% of the total population. Densities were expressed in this report as numbers of fry per m of reach length. It removes the annual variation in stream width due to discharge variations and it allowed us to directly use the first data year, 1991, when we did not measure the area of water greater than 10 cm deep (‘pool’ area). Number per pool area is the other favoured measure of coho density.

Fork lengths were recorded and scales taken from fish that may have been older than underyearlings. Where the catch in the measured section was less than 100 fry, we usually extended sampling immediately upstream and/or downstream from the density reach to obtain a larger sample. We did not do this if catches were so poor that obtaining an adequate sample was not practical. The catches in the extended reach areas were not used to calculate density and the sample data were recorded separately from the sample data in the density reach. Kent Simpson and Rick Semple have the fry density and size data from non-Fraser and lower Fraser streams, respectively.

2.5 Area-Under-the-Curve Escapement Estimates

Approximately weekly foot surveys have been made through the main coho spawning period (October to between the end of December and mid-January) in six tributaries in the Cowichan River system, in 17 other Vancouver Island streams and in 18 streams between Squamish and Hope (lower Fraser/Lower Mainland or LFLM). As mentioned, coho in the Cowichan streams have been counted since 1989. The other streams were only covered thoroughly enough to generate useful AUC estimates beginning in 1998. Charter patrolmen and stewardship and Native groups collect escapement information on other streams but the amount of data is inadequate to estimate a coho escapement and some stocks are heavily enhanced. Hatchery-reared fry were also planted in nine of the 17 Vancouver Island streams that we surveyed for the first time last year, with six plants possibly contributing to more than 25% of the escapement, assuming they survived about as well as wild fry.

The census was conducted as follows. Two workers waded or snorkelled in the creek prodding into cover for hiding fish, obtaining an observed and estimated count of jacks and adults, live and dead. Dead and moribund fish were sampled for size, mark status and age structures. Most or all the length of stream utilised by spawners was covered and the same reach was (or will be) surveyed each year. Crews were asked to record their estimate of the actual number of spawners present in the reach on each visit as well as the observed number in order to subjectively compensate for weekly differences in observation efficiency.

AUC abundance estimates (e.g. Irvine et al. 1993) are calculated using the estimated numbers and survey lives. Survey lives used on Vancouver Island streams were based on measurements in the Cowichan system and elsewhere. Often difficult to measure accurately, survey lives appear to be correlated with stream size – coho tend to occupy larger streams longer. The primary data sources from the Cowichan were recoveries of coho tagged near the time of their entry into a moderate sized stream (Shaw Creek), seven years of spawner observations by the senior author in seven to nine other Cowichan tributaries and especially from tagging studies conducted at the Mesachie Creek fence (Holtby 1993). Other data came from the literature, e.g. Perrin and Irvine 1990. Between streams, survey life measurements usually fall between 7 and 14 days (d). The average found by Perrin and Irvine was 11.4 d. The survey lives used were selected based on stream size and modified in some cases by observations by the sampling crew and varied from 9 in small streams to 14 d in moderate sized streams. One exception was the Trent River, where a life of 21 d was used. Annual variation in survey lives within small to moderate sized streams is less in our experience than variation between streams of different size.

A different approach was used in the Fraser River Salmon Section for the 18 LFLM streams in 1998, which led to use of a shorter survey life on the mainland. Data from intensive surveys in Salmon River were used to derive a stream residence time of 7.4 days that was used to calculate AUC estimates in other streams in the set. We also used the ratio of the Petersen MR population estimate and the peak expanded live count of coho in Salmon River (estimated at 2.28) as a multiplier to raise peak estimated live counts of coho in other streams within the escapement indicator set. These alternative escapement estimates are not presented here but it is worth noting that, while some of the alternative estimates for some of the streams varied by as much as 100%, the sum of all escapements in the set was within half a percent of the AUC estimate.

It must be stressed, however, that the choice of life was to an extent arbitrary even though the choice directly determines the AUC escapement estimate (which equals fish-days divided by survey life). These AUC estimates are used to index annual trends under the assumption of small annual variation in survey life within streams. However, other analyses which use the escapement estimates, rather than changes in the estimates, should recognise the possibility of biases. For example, comparisons between mainland and Vancouver Island streams should be made cautiously because the differences in survey lives used may reflect method more than reality.

We estimated the first generation enhanced component of escapements to those Vancouver Island streams that have received fry plants or smolt releases. To estimate the contribution from fry plants, 15% of planted fry were assumed to survive to smolts, a rate typical of wild fry. Many assessments of fry plants show that actual survivals are likely to be much less than this (e.g. Solazzi et al. 1990) and therefore our estimates of enhanced contribution to escapements are probably over-estimates. The survival of enhanced smolts to the escapement was then estimated using the Black Creek smolt survival to the escapement (4.4%). A wild survival was used on the assumption that smolts that survived from a fry plant would not survive differently than wild smolts in the ocean. The contribution to the 1998 escapement from smolt releases was estimated in each stream by using smolt survivals to the escapement of Big Qualicum Hatchery releases (excluding tag groups that were pelvic clipped). Estimates of enhanced contributions to previous Chase River escapements were calculated the same way, by using previous smolt to escapement survivals at Big Qualicum Hatchery.

Multiple visit visual and MR estimates of wild escapements began in 1995 on the Sunshine Coast (e.g. Myers and Wilson creeks) but on the whole, consistency and frequency of enumerations has been insufficient. Most of the streams being monitored on the Sunshine Coast are also enhanced or have active and significant habitat restoration efforts, reducing their usefulness as indicators for Areas 15 and 16. This GSMN region remains the weakest area for coho assessments and more Stock Assessment Division (StAD) support is needed here.

2.6 Survival and Exploitation

All our survival and exploitation analyses follow the current convention of not including age .0 catches and escapements (jacks).

Nor do the survivals in this or previous reports account for mortality of adult coho that were released after capture. It is important to realise that the resultant under-estimation of survival and exploitation becomes larger in relative terms when catch is small and retention restrictions increase release rates, as in 1998. To estimate actual fishing mortality in 1998, Holtby et al. (1999) accounted for release mortality by assuming a 5% Canadian exploitation rate and a Washington/Oregon rate of 50% of their historic average exploitation. We now have the Washington recoveries and used them in our calculations. Holtby also did not restrict codes to those approved for survival/exploitation analysis, although this difference would be minor in 1998. We both excluded pelvic clip tag groups since this marking was expected to cause possibly significant mortalities. We show Holtby's estimates of 1998 survival for comparison.

Holtby et al. (1999) recently estimated the sport catch of tagged Chilliwack Hatchery coho in the Chilliwack/Vedder River by applying the mark rate at the hatchery to the creel survey estimate of total catch. We took a different approach for this report, the same as used by Simpson et al. (1997), which was to estimate the survival of Chilliwack Hatchery coho by dividing their survival to the fishery (marine catch/smolts) by the marine exploitation of nearby Inch Hatchery coho. Marine exploitations in this report are defined as marine catch divided by the sum of total catch and escapement. This is more indicative of wild exploitation than total exploitation because it excludes freshwater catch, which is often a significant portion of the catch of hatchery stocks but not wild stocks (especially in 1998). We took this approach because the freshwater sport catch estimate in Chilliwack is for jacks and adults combined. Since angling is selective for jacks, using the jack rate at the hatchery to estimate the age composition in the river catch is not valid. Also, Simpson et al. showed, using the range of Inch exploitations at the time (1997), that the assumption of equal exploitations was robust. The use of Inch is supported by the strong correlation between Inch and Chilliwack in the proportion each stock is caught in 'inside' waters (correlation of 0.91, from Holtby et al., 1999).

3 STOCK STATUS UPDATE

3.1 Juvenile Abundance

3.1.1 Fry

Fry densities (Table 1) were highest in the1990 brood year (BY), the first year of the survey, then centred around 5.5 to 7.5 fry/m from 1991 to 1995 BY's and dropped to about 4 fry/m in 1996 and 1997 BY's (Fig. 1). Summarised over the Basin, the size of fry (Table 2) changed little through this period except in the 1996 BY when mean fry sizes were larger, coincident with their low density (Fig. 2). This brood year will return in 1999. It is a common observation that over-winter survival of fry is positively correlated with their fork length in the fall (e.g. Holtby 1988) so low fry densities in the 1996 BY may not have carried through to reduced smolt outputs. In fact, this brood has survived very well in the Black Creek system (see 3.1.2 Smolts). Of course, density is not the only determinant of fry size and the 1997 brood was back to the pre-1996 size range, despite being almost as sparse as the 1996 brood fry. The mid-summer to mid-fall of 1998 was especially dry, which may have retarded growth. Smolt outputs in 1999 may be depressed as a result.

That fry sizes are usually negatively correlated with density is more apparent when parts of the Basin are looked at (Areas 13/14, 17/19, 15/16/28 and 29B-E). Data pairs for the correlation in each region were median density taking all eligible sites (sites within a stream were not aggregated) and mean size and the correlation was calculated across years. The streams/sites are shown in Table 1. Data were selected largely on the basis of having no or very little fish supplementation. A few were rejected due to sampling problems, e.g. the site frequently drying into isolated pools. Density:size correlations were –0.81*, -0.62, -0.02, and –0.47 respectively and the overall correlation was –0.55. The Sunshine Coast/Squamish sub-area (15/16/28) is our smallest data set but we do not have an explanation at this point for the non-existent density:size correlation.

StAD intends to review the fry survey methodology and more thoroughly analyse its results this year. For example, its use in predicting smolt yields will be examined. However, a preliminary examination of the use of fall fry densities for estimating parental escapements as a partial alternative to costly, time consuming and sometimes ineffective spawner enumerations shows the survey has some merit. AUC spawner enumerations on the south coast cost about 4 times as much as fry assessments per stream. We calculated a crude index of coho escapements in the Basin by taking the median AUC estimates from the Cowichan system and the mark-recapture estimates from Black Creek and Salmon River. As will be seen in the escapement section following, each shows a different escapement pattern but there is some evidence to support the hope that each is representative of a portion of the Basin. We scaled each 1990-97 data series by dividing each year's escapement by the average escapement for the system in that period. The three scaled escapements in each year were averaged to produce the escapement trend shown in Fig. 1.

There is a significant correlation (0.80*) between fry density and parental escapement with the major deviation occurring in the first two years of the period when escapements were highest. Our interpretation is that, especially at low escapements, fry densities are usually indicative of parental escapements the previous fall. At escapements equal to or exceeding the levels seen in 1990 and 1991, density dependent mortality becomes more apparent, limiting the number of fry. At least at low escapements, surveying only one or two sites per stream once per year provides an indication of trends in parental escapement. This was shown for Carnation Creek by Holtby (Simpson et al. 1996; B. Holtby, pers. comm.) and is confirmed at Black Creek (Fig. 3). The relationship is not as clear in the Salmon system, however (Fig. 3). For no reason that we can determine, the 1993 BY fry density in Coghlan Creek did not reflect the relatively large parental escapement estimate to the Salmon River system.

One possibility that will be considered in the review of fry assessments will be using the fry data to define the geographic matrix of escapement, smolt and fry indicators needed to accurately depict the status of Georgia Basin coho at least cost. The fry survey has the most geographic coverage of any assessment we do.

3.1.2 Smolts

The only time series of smolt counts from wild populations in the Basin come from Black Creek and Salmon River. The smolt index at Salmon River (based on mark rates of returning adults, Sect. 2.1.2) declined markedly from the first estimate in 1986 until 1993 and have since stabilised at 100,000 -125,000 (Fig. 4). Black smolts have not trended as strongly. However, the three smallest smolt runs in the 16 year record have occurred in the last four years (1993, 1994 and 1996 brood years, Table 3).

Black Creek had a very good smolt run in 1997. The age 1. smolt run in 1997 and age 2. smolts in 1998 are the product of a good freshwater survival of 86 smolts/female. The 1998 smolt run was only 21,324 but the parental escapement estimate of only 126 females was a record low. As discussed in Section 3.1.1, the fry were correspondingly sparse but relatively large. There were 169 age 1. smolts per female, much higher than the average of 59 age 1. and 2. smolts per female before the 1996 brood year. We have already said that we believe this to be largely a density effect related to their large size as they enter the winter mortality period. However, the size of fry in the previous brood was not remarkable (Table 2) and did not presage their good survival (86 smolts/female) which was presumably due to favourable environmental conditions.

The average smolts per female at Salmon River is similar to Black: 64 before the 1996 brood year (without allowance for the small age 2. component). The comparable 1998 smolt run estimate using the mark rate of the subsequent escapement will not be available until this year's escapement. The average smolts/female in the 1989, 1993 and 1995 brood years when there were similar escapements to 1996 was 81. Using this figure with the 1996 escapement produces an estimate of the 1998 smolt run of 107,000, little different from the preceding four years. The smolt run estimate using the fence recoveries of marked smolts is 59,800. We need to obtain the smolt estimate using marked spawners to get closer to a conclusion on why the estimates are so different. There may be significant errors in one or both estimation methods or freshwater survival may have been much less in this brood than the three reference broods. There are some doubts about the accuracy of the smolt index, partly due to the very large number of smolts per km of mainstem length in the early years. Using the mainstem length

estimate of 27km, admittedly a large underestimate of rearing length, the number of smolts per km averaged about 8,000, substantially more than reported for any other North American stream. The maximum mean smolts/km found in Bradford et al.'s (1997) review of North American data was 4,317 for Rust Creek, a very small tributary adjacent to a pond in the Chilliwack/Vedder system (Federenko and Cook 1982).

To summarise, the smolt outputs from the Lower Mainland indicator may not have changed much since 1994 but smolts from the central Vancouver Island indicator have gone from above average to below average twice in the same period. Bearing in mind that both indicators are productive coho systems (Bradford et al 1997) and considering that both indicators have frequently had below average smolt runs in the last several years despite their productivity, we submit that regional recruitment of wild smolts to the ocean has probably been below average also. At Black Creek an almost three fold increase in freshwater survival of 1996 brood fry did not fully compensate for the extremely poor escapement and a below average smolt run resulted. Of course, looked at over a longer term declines are a general phenomenon, linked to habitat losses (although perhaps not as rapid as we see in the complete Salmon River time series). One can assume the documented loss of freshwater rearing habitat in the Georgia Basin has had a long term serious impact. With further analysis it should be possible to draw more conclusions by using the fry data to estimate smolt densities.

Smolt releases from Puget Sound/Juan de Fuca hatcheries have declined by 16.3 million in the 1991 to 1995 brood year period and Strait of Georgia/Johnstone Strait production has declined by 2.4 million in the same period for a total of 18.7 million fewer smolts (Fig. 5). The 1995 brood year smolt production from these 'inside' areas was 38.6 million, 77% of the 1981-90 average.

3.2 Catch

About 148,000 coho were landed in 1997 in southern BC fisheries as indicated by sales slip records and creel surveys (Table 5). With the total ban on coho retention in 1998, only 1,550 coho salmon were recorded in landings from all southern BC commercial and sport fisheries (due to mis-identification of species by fishermen for example). Up to 1986, the annual catch was usually in the 2.5 to 3.5 million range but then catches began to decline: the five year averages for 1983-87,1988-92 and 1993-97 are 3.23, 2.96 and 1.34 million coho, respectively (Fig. 6). The declining catches occurred both inside and outside the Strait of Georgia (Table 5) although the relative change in catch between these areas was variable between years.

The estimated kill of coho in southern BC in 1998 was 23,030 fish (Table below; pers. comm. B. Shaw, DFO, 3225 Stephenson Point Rd. Nanaimo). It includes the recorded catch of 1,550 and estimates of release mortalities, calculated by applying fisheries-specific mortality rates to the number of coho caught and released. The rates used were 26%, 25%, 60% and 10% for troll, seine, gillnet and sport, respectively:

Fishery	Encounters	Mortalities
Commercial	21,268	8,887
Recreational	88,136	8,814
First Nations (Fraser R.)	191	115
Test Fisheries	6,910	1,945
Experimental	32,020	3,270
Total	148,525	23,030

We have chosen to report the landed catches in southern BC commercial and sport fisheries to maintain consistency and comparability with the catch records of previous years.

The small catch of coho in southern BC in 1998 was attributable to stringent conservation measures imposed by the Minister to protect declining wild coho stocks. These included – zero fishing mortality for coho stocks from the upper Skeena and Thompson rivers and minimal risk of by-catch for all other coho, coho non-possession and non-retention, no directed coho fisheries and selective fishing only where fishermen could demonstrate minimal risk of coho by-catch mortality. However, decreasing catches from 1990 to 1996 were due to declines in abundance. Firstly, exploitation rates only began decreasing in 1995 (see Section 3.6, below). Secondly, although smolt releases by Washington and Georgia Basin hatcheries have declined (Fig. 5), the first catch year affected was not until 1995. Wild smolt productions from Black and Salmon were not trending down in this period either, although their average 1990's smolt production has been less (Fig. 4). It appears that reduced catches reflected reduced abundance. Reduced abundances may be partly the result of decreased wild and enhanced production but we will show below that lower smolt to adult survival is the over-riding cause.

3.3 Catch Distribution

Prior to the major fishing restrictions imposed in 1998, Georgia Basin stocks[1] were mostly caught in the Strait of Georgia/Fraser River ('inside') sport and troll fisheries, in the "outside" troll, sport and net fisheries off the west coast of Vancouver Island and in Juan de Fuca and Johnstone straits. The Strait of Georgia troll fishery has had a coho non-retention restriction since 1995. Also in 1995, the recreational daily bag limit was reduced in Johnstone and Georgia straits from 4 to 2 coho and the size limit was increased from 30 cm to 41 cm. Bearing these influences in mind, we still think it is acceptable to use, as Kadowaki et al. (1996) did, the proportion of recoveries of tagged Georgia Basin coho in the Strait of Georgia as an indicator of inside/outside distributions before 1998. The phenomenon is sufficiently marked that it overwhelms data problems like the above (and others such as a portion of the inside sport catch consisting of inward bound coho in the fall, which could be easily excluded, and exacerbation of high and low inside recoveries due to increases and declines in effort in response to high and low abundance).

Detailed catch distribution (tag recovery) data are given in Tables 6 to 11 for Quinsam, Big Qualicum, Inch and Chilliwack hatchery stocks and Black and Salmon wild stocks, respectively. There is a key to the catch region codes in Table 4.

Recoveries before 1998 of tagged coho from the four hatchery and two wild indicator stocks indicate that an unusually high proportion of coho ranged out of the Strait of Georgia to the west coast of Vancouver Island in 1991 and from 1994 to 1997 (Fig. 7). Using proportions averaged over the five groups, only 10, 33, 6, 10 and 5 percent of the recoveries of tagged coho were in the Strait of Georgia in those years. Such low proportions had not been seen since tagging began 20 years ago. By comparison, the inside proportion was 80% in 1993. The troll catch in the Strait in 1991 was the lowest since records began in the early 1950's, suggesting that never in that 40 year period had there been fewer coho inside (Kadowaki et al. 1996). We think that it is an actual distribution shift and is not due to very poor inside survivals because marine survivals of indicator stocks have not declined in outside years to an extent that the requisite near total inside mortality would require.

1998 was clearly another 'outside' year. The Strait of Georgia Creel Survey recorded only 462 coho encountered in 8,741 trips in Areas 17 and 18 up to the end of August (T. Carter, pers. comm.). Coho encounters up to the end of August in the Strait of Georgia sport fishery were estimated to be only 4,210 in the final in-season estimate from Operations Branch (B. Shaw, pers. comm., DFO, 3225 Stephenson Point Rd. Nanaimo).

[1] Meaning coho originating in streams in the Georgia Basin as we have defined it, not coho present in the Strait of Georgia.

3.4 Escapement to Streams

All but one stock monitored on the east coast of Vancouver Island (ECVI) had improved escapements in 1997 over the extremely poor escapement in 1996 and they improved again in 1998 (Table 12). The Black Creek escapement in 1998 was exceptional (Fig. 8). It had an escapement of over six times that of 1997, over four times the brood year escapement and over twice the MSY goal of 3,150 adults (Kadowaki et al. 1995). Only an estimated 3,085 or 40.5% of the 7,616 estimated return were tagged, as discussed in Section 2.1.1. In 1997, the estimated tagged escapement was 235 or 19.6% of the total and in 1996 it was 182 or 64%. The tagged proportion averaged 74% before 1996. Although it seems unlikely, we are forced to consider that the untagged portions of these runs are strays from nearby Oyster River which has an enhancement program. There were 180,000 fry released in the Oyster system in 1996 and 60,000 smolts in 1997. Assuming 15% of the fry survived to smolt (a probable over-estimate as mentioned in section 2.5.1) and assuming the same survival of 4.4% to escapement as Black smolts, the enhanced Oyster escapement estimate is 3,834. This probable over-estimate still does not account for the estimated 4,531 unclipped coho in Black Creek. Hence, at least some of the strays must have been wild Oyster coho if this is the explanation. We have had virtually no tagged strays into Black from Quinsam Hatchery nor have tagged Black coho been recovered anywhere else except a few in Oyster. We stress that, if this is the reason, it affects how we interpret total escapements and freshwater productivity – it does not affect marine survival and exploitation estimates from Black Creek because only tagged escapements are used in those calculations. We will be investigating the cause of this low tag proportion further. Looking only at the tagged escapements since 1996, the picture changes to the extent that the 1997 tagged escapement was almost equally poor to 1996. The tagged escapement in 1998 of 3,085 is still the best since 1991.

Other escapements in the Black Creek area were much improved in 1998 also: Oyster River and Village Bay Creek, both enhanced, had excellent escapements: estimates based on incomplete but better than average quality counts were 9,000 and 3,500 respectively, both much higher than seen before. [2]

Further south on Vancouver Island, the next time series is from Chase River, which has received smolt releases (Section 2.2.1). The total escapement estimate in Chase River has improved since 1996 but only a little (Table 12; Fig. 9). The estimated wild component improved better in relative terms in 1998 (from an estimated near zero contribution in 1997). Before 1998, wild escapements had been decreasing since 1994 and escapements are still poor relative to earlier this decade.

Further south yet, the 1998 median escapement to Mesachie Creek and other Cowichan River tributaries (Richards, Oliver, Patricia and Shaw creeks) was triple that of 1997 although 1997 was little improved over the very bad 1996 escapement. The 1998 escapement represented a 62% increase over the brood year escapement in 1995.

[2] BCMOELP conducted one swim in the Oyster and counted 2,400 coho and the stewardship group on Oyster River estimated a run of at least double the recent past. The Quadra Island Enhancement Society counted 3,500 coho during the main influx into Village Bay Creek over a few days.

While escapements in these streams increased in 1997 and 1998 with the virtual cessation of fishing, present levels in some of them like Mesachie (run reconstruction, Holtby 1993) and Oliver Creek (fence count) are less than half those in 1941-44, when escapements averaged 1,852 and 462 coho, respectively (Fig. 10). As late as 1984, escapements to Mesachie were estimated to be twice the 1998 escapement.

Escapements to the wild indicator streams in the lower Fraser River, namely Salmon River and upper Pitt River, also increased from 1996 to 1997 but unlike those on ECVI escapements did not further improve in 1998 (Table 12; Fig. 11). The escapements in 1996 to these mainland indicators were not as poor as elsewhere. The 1997 escapements also represented an improvement over brood like on Vancouver Island but the 1998 return to Salmon was a 29% decrease from the brood year escapement. Only Shaw Creek and Chase River stocks on Vancouver Island were poorer than brood.

The Petersen MR estimate of 2,993 adult coho in Salmon River in 1998 is small relative to less recent years like 1987-91 when the escapement averaged 7,758 fish annually. Upper Pitt River does not have the same downward escapement trend as Salmon River. While it showed decreased escapement in 1998 from the previous year, escapements have remained relatively strong (Fig. 11).

The lack of correlation between Upper Pitt and Salmon escapements which are 50 km apart contrasts with a significant correspondence between Chase escapements and those in the Cowichan system, 40 km south (Fig. 12). Salmon River is very different from Upper Pitt River (Sections 2.1.2 and 2.1.3) and this illustrates the need for a sample of representative habitat types in assessment planning. An even broader correlation is found on the west coast of Vancouver Island between Carnation Creek, Stamp River and Gold River (Simpson 1998) and Carnation is a small stream, very different from the latter two rivers. The WCVI correlation is consistent with the observation that ocean survival is of over-riding importance at this time: correlations in escapement probably reflect similar ocean rearing conditions. We submit that there are likely more ocean rearing options available to inside stocks. While most WCVI coho appear to rear along the west coast of the island (at least in their catchable second year), Black Creek coho, for example, may rear in the Strait of Georgia or move north into and through Johnstone Strait or move out through Juan de Fuca Strait. And it is not unreasonable to expect the Strait itself to be a particularly diverse rearing environment. It is not surprising that Black Creek escapements should differ in pattern from stocks further south.

Although very different habitats, one might expect smolt survivals, marine distributions and escapements to be similar or correlated in streams as close as upper Pitt and Salmon but their escapement patterns are dissimilar. In fact, in the 1978 brood year when both Salmon and Pitt coho were CWT'd, Pitt smolts were subsequently caught 'outside' much more than Salmon coho: only 15% of the Pitt recoveries were in the Strait of Georgia but 44% of Salmon recoveries were 'inside'. While there appears to be some regional cohesiveness in our ability to detect major year class variations, it will require other data such as extensive fry and catch distribution data to define the network of escapement indicator streams.

We include the female spawning indices (No./km) for an extensive set of forty-two streams in the Georgia Basin as a baseline data set which will increase in value as a larger time series is developed (Table 13). Because there were only from 2 to 9 streams examined in each area in 1998, the confidence in making between area escapement comparisons is diminished. It is especially difficult to compare mainland escapements with Vancouver Island escapements because of the different methods used to derive

survey lives. We considered assigning an average life, say 10 days, and re-calculating estimates but felt that the single year of data does not justify more than a data record. Note that the mainland coast north of Squamish is not represented in this data set and we intend to obtain data from there in 1999. On the other hand, all of the streams monitored in Areas 28 and 29 are wild streams but we found that hatchery strays, particularly from Capilano Hatchery, pose significant "noise" to the interpretation of escapements in Area 28A streams which empty into Burrard Inlet. These streams should not be included in future surveys. The data set indicates overall that the number of females per kilometre was what many would characterise as at least adequate (overall median of 42 per kilometre).

Extensive escapement surveys of lesser precision which we started in 1998 will help us to further define the nature of the escapement indicator network i.e. what are the areas or types of streams with similar escapement patterns. We feel that the SEDS database, which is largely based on single or sporadic surveys and often not when and where most coho spawn, is likely insufficient to determine this but a careful examination of the historic data may reveal patterns also.

3.5 Marine Survival

Based on coded wire tag recoveries in catches and escapements, the 1994 brood year survival of smolts from Quinsam, Big Qualicum, Inch and Chilliwack hatcheries to the adult catch and escapement ranged from 1.0 to 1.8 percent (Table 14). These survivals of coho returning in 1997 were the lowest since the 1973 brood year when data records began.

Survival estimates for the hatchery indicators dropped even further in the 1995 brood year to a range of 0.3 to 1.0 percent. An alternate estimate of survivals, assuming a 5% exploitation in Canadian fisheries and half the historic average exploitation in southern US fisheries, ranged from 0.3 to 2.1 percent (Holtby et al. 1999):

	1995 Brood Year Survival Estimates	
	This Report	From Holtby et al. (1999)
Quinsam	1.0	2.1
Big Qualicum	0.3	0.3
Inch	0.5	0.5
Chilliwack	0.8	(2.1)[1]
Black	4.5	4.8
Salmon	2.5	-

[1] See text, below.

Although we feel that calculating the survival of Chilliwack coho by using the marine exploitation of Inch coho is appropriate, the relative error increases with lower survivals and exploitations like we are now seeing. For example, if the estimated exploitation of Salmon River wild coho (1.7%) is used instead of the Inch exploitation of 9.6%, the Chilliwack survival estimate would be 4.5%. This is in addition to the increased relative error expected from very low catches, mentioned above.

The survival of 1994 and 1995 brood coho in Black Creek (4.4% and 4.5%, Table 14) remained little changed over the previous two years. The decline in survival of Salmon coho still has not abated however, reaching 2.5% for the 1995 brood. The tagged release from Salmon was only 5,676, so this estimate is subject to greater than usual error. Hatchery coho continued to survive more poorly than the two wild stocks but they correlate very well with them overall (Fig. 13).

Given the uncertainties surrounding the estimates in 1998, we conclude that survivals of Georgia Basin stocks were certainly very poor. Survivals of stocks in the middle and southern Basin probably declined from 1997 (1994 brood). Black and Quinsam survivals have remained static over the last four and three years, respectively.

Looking at the entire data record, the pattern of survival is different between the mainland indicators and Vancouver Island indicators (Fig. 13). There was a multi-year peak in survival of mainland hatchery and wild indicators centred on the 1985 brood year and an overall decline since, broken by fairly stable survivals in the 1988 to 1993 brood years.

Fish culture problems at Big Qualicum in the 1980's cloud interpretation of the Vancouver Island pattern. The 1983 to 1986 brood year survivals for Big Qualicum should be given little or no weight. Big Qualicum and Black survivals were very high in the 1970's. Black was stable at a moderate survival through much of the 1980's. Up to this time, Quinsam was stable at about 5 -10%. Coho from all three ECVI indicators began surviving more poorly starting between the 1987 and 1990 brood years, one to three years after the start of the mainland decline.

The 1995 brood survivals are only for coho that did not receive a pelvic fin clip in addition to the adipose clip – survivals of Big Qualicum, Inch and Chilliwack coho using all releases were 0.15, 0.5 and 0.6 percent because pelvic/adipose clipped coho did not survival as well as adipose-only clips (Table 15). The mean survival of pelvic clipped coho was 0.36% versus 0.58% for coho with only an adipose clip, a 38% difference in survival. Remember all these survivals here and elsewhere in this section refer only to adult catches and escapements, i.e. jacks are not considered.

3.6 Exploitation

Exploitations are shown in Table 16 and Fig. 14. As already noted, exploitations based on recorded catch are under-estimated but in terms of relative error they are especially uncertain in 1998. The table shows total and marine exploitations based on recorded catches. Quinsam and Black exploitations were 2.5 – 3.0%. Further south, Big Qualicum and Inch were about 9%. The Salmon River exploitation estimate was only 1.7%. This may be due to the small tag group released in 1997 but it follows a pattern of low exploitations of Salmon River coho relative to other stocks in recent years. Its escapements have been relatively stable (CV = 31% vs. 89% for Vancouver Island stocks) as has the smolt output. We do not know why but the diminishing returns of Salmon River coho in recent years are mostly reflected in smaller catches rather than smaller escapements.

4 CONCLUSIONS

1. The currently low productivity of Georgia Basin coho aggregates means that fishing mortality must be kept to a minimum to conserve and rebuild these populations.

2. There was a record poor brood escapement in 1996 in most areas and this brood's smolt migrations were probably weak in 1998.

3. Escapements in 1997 were improved over the previous year but remained below average overall. Some were better than the brood year (Black Creek and the lower Fraser indicators) and others were generally worse (SE Vancouver Island).

4. 1998 escapements generally responded strongly in the northern Strait to cessation of directed fishing, responded sluggishly in the southern Strait but very low exploitations did not compensate for increased natural mortality in lower Fraser stocks.

5. Extremely low marine survival is the driving short term cause of poor returns and survivals continued to decline in the southern Strait.

6. Coho marked with a double fin clip (adipose and single pelvic) survived on average 38% more poorly than coho marked only with a adipose fin clip.

7. Georgia Basin coho have now largely migrated 'outside' for four years.

8. The fry survey holds promise as an extensive assessment tool and results support the escapement trends observed at the few indicator sites. A review of the method is required.

9. Extensive AUC escapement surveys need to be developed further, particularly with respect to observer efficiency and survey life determinations.

10. A 'full' indicator facility is needed on the Sunshine Coast where juveniles are enumerated and tagged and adults are accurately counted and sampled. Another one is required in the Lower Mainland. Consideration should be given to alternatives to AUC estimates and counting fences, e.g. electronic counters.

5 ACKNOWLEDGEMENTS

The authors wish to thank the people in the field whose work made this analysis possible.

6 REFERENCES

Argue, A.W., J. Coursley, and G.D. Harris. 1977. Preliminary revision of Georgia Strait and Juan de Fuca Strait tidal salmon sport catch statistics, 1972 to 1976, based on Georgia Strait Head Recovery Program data. Fish. Mar. Serv. Tech. Rep. PAC/T-77-16: 68p.

Argue, A.W., L.M. Patterson and R.W. Armstrong. 1979. Trapping and coded-wire tagging of wild coho, chinook and steelhead juveniles from the Cowichan-Koksilah River system, 1976. Fish. Mar. Serv. Tech. Rep. 850: 117p.

Armstrong, R.W., and A.W. Argue. 1977. Trapping and coded-wire tagging of wild coho and chinook juveniles from the Cowichan River system, 1975. Fish. Mar. Serv. Tech. Rep. PAC/T-77-14: 58p.

Aro, K.V., and M.P. Shepard. 1967. Pacific salmon in Canada. pp. 225-327 in Salmon of the north Pacific Ocean – Part IV. Spawning populations of north Pacific salmon. Intern. North Pac. Fish. Comm. Bull. 23.

Bison, R. 1992. The interception of steelhead, chinook, and coho salmon during three commercial gill net openings at Nitinat, 1991. Report to file, British Columbia Ministry of Environment, Lands and Parks, Fisheries Branch, Kamloops, BC.

Bocking, R.C., J.R. Irvine and R.E. Bailey. 1991. Enumeration and coded-wire tagging of coho salmon (*Oncorhynchus kisutch*) smolts leaving Black Creek, French Creek, and the Trent River on Vancouver Island during 1989. Can. MS Rep. Fish. Aquat. Sci. 2115: 103 p.

Bocking, R.C., J.R. Irvine and R.E. Bailey. 1992. Coho salmon (*Oncorhynchus kisutch*) escapement studies in Black Creek, French Creek, and Trent River, Vancouver Island, 1989. Can. MS Rep. Fish. Aquat. Sci. 2160: 77p.

Bradford, M.J., G.C. Taylor, and J.A. Allan. 1997. Empirical review of coho salmon smolt abundance and the prediction of smolt production at the regional level. Trans. Am. Fish. Soc. 126: 49-64.

Brown, T.G., L. Barton, and G. Langford. 1996. The use of a Geographic Information System to evaluate Terrain Resource Information Management (TRIM) maps and to measure land use patterns for Black Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2395: 34p.

Clarke, D.G., and J.R. Irvine. 1989. Enumeration and coded-wire tagging of coho salmon (*Oncorhynchus kisutch*) smolts leaving Black Creek, Vancouver Island, during 1978 and 1979, their subsequent distribution in sport and commercial fisheries and escapement to the creek in 1978-1980. Can. MS Rep. Fish. Aquat. Sci. 2017: 45p.

Elson, M.S. 1985. A review of the Pitt Lake watershed. Prepared for New Projects Unit, Salmonid Enhancement Program, Can. Dept. Fish. Oceans, Vancouver, B.C. 128 p.

Farwell, M.K., N.D. Schubert, K.H. Wilson, and C.R. Harrison. 1987. Salmon escapements to streams entering statistical areas 28 and 29, 1951 to 1985. Can. Data Rep. Fish. Aquat. Sci. 601: 166p.

Farwell, M.K., N.D. Schubert, and L.W. Kalnin. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1988 tag application and 1989-90 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2079: 32p.

Farwell, M.K., N.D. Schubert, and L.W. Kalnin. 1992a. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1989 tag application and 1990-91 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2114: 32p.

Farwell, M.K., N.D. Schubert, and L.W. Kalnin. 1992b. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1990 tag application and 1991-92 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2153: 42p.

Fedorenko, A.Y., and R.J. Cook. 1982. Trapping and coded wire tagging of wild coho juveniles in the Vedder-Chilliwack River, 1976 to 1979. Can. MS Rep. Fish. Aquat. Sci. 1678: 79p.

Fielden, R.J., G.J. Birch, and J.R. Irvine. 1989. Enumeration and coded-wire tagging of coho salmon (*Oncorhynchus kisutch*) smolts leaving Black Creek, French Creek and Trent River, Vancouver Island, during 1988. Can. MS Rep. Fish. Aquat. Sci. 2018: 85p.

Hickey, D.G., I.W. Whyte, and N.D. Schubert. 1987. An assessment of the fall Vedder-Chilliwack River sport fishery, 1985. Can. MS Rep. Fish. Aquat. Sci. 1908: 25p.

Holtby, L.B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and associated impacts on the coho salmon (*Oncorhynchus kisutch*). Can. J. Fish. Aquat. Sci. 45:502-515.

Holtby, L.B. 1993. Escapement trends in Mesachie Lake coho salmon with comments on Cowichan Lake coho salmon. PSARC Working Paper S93-3.

Holtby, B., J. Irvine, R. Tanasichuk and K. Simpson. 1999. Forecast for southern British Columbia coho salmon in 1999. Canadian Stock Assessment Research Document 99/125.

Irvine, J.R., J.F.T. Morris, and L.M. Cobb. 1993. Area-under-the-curve salmon escapement estimation manual. Can. Tech. Rep. Fish. Aquat. Sci. 1932: 84p.

Irvine, J.R., R.E. Bailey, D. Imhof, F.C. Dalziel, W. Pennell, and C. Chesnut. 1994. Coho salmon (*Oncorhynchus kisutch*) spawning enumeration and related studies at Chase River and Beck Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2264: 31p.

Irvine, J. R., R. E. Bailey, M. J. Bradford, R. K. Kadowaki, and W. S. Shaw. 1999 Assessment of Thompson River/Upper Fraser River Coho Salmon. Canadian Stock Assessment Research Document 99/128.

Kadowaki, R., J. Irvine, B. Holtby, N. Schubert, K. Simpson, R. Bailey, and C. Cross. 1995. Assessment of Strait of Georgia coho salmon stocks (including the Fraser River). PSARC Working Paper S94-9.

Kadowaki, R., B. Holtby, K. Simpson, and D. Blackbourn. 1996. An update of assessment information for Strait of Georgia coho salmon stocks with 1996 forecasts and advice on setting an exploitation rate target. PSARC Working Paper S96-11.

Kalnin, L.W., and N.D. Schubert. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1987 tag application and 1988-89 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2068: 37p.

Labelle, M. 1990a. A comparative study of coho stocks of SE Vancouver Island, British Columbia. Juvenile outmigration, coded wire tagging and recovery, escapement enumeration and stock composition at Black Creek, Trent River and French Creek, 1984-1988. Can. Tech. Rep. Fish. Aquat. Sci. 1722: 148p.

Labelle, M. 1990b. A comparative study of the demographic traits and exploitation patterns of coho salmon stocks from SE Vancouver Island, B.C. Ph.D. thesis, The University of British Columbia. 264p.

Lister, D.B., L.M. Thorson and I. Wallace. 1981. Chinook and coho salmon escapements and coded-wire tag returns to the Cowichan-Koksilah River system 1976-1979. Can. Man. Rep. Fish. Aquat. Sci. 1608: 78p.

Nass, B.L., J. Carolsfeld, J.R. Irvine, and R.E. Bailey. 1993a. Enumeration and coded-wire tagging of coho salmon (*Oncorhynchus kisutch*) smolts leaving Black Creek, French Creek, and the Trent River on Vancouver Island during 1990. Can. MS Rep. Fish. Aquat. Sci. 2206: 82p.

Nass, B.L., R.C. Bocking, R.E. Bailey, and J.R. Irvine. 1993b. Coho salmon (*Oncorhynchus kisutch*) escapement studies in Black Creek, French Creek, and Trent River, Vancouver Island, 1990. Can. MS Rep. Fish. Aquat. Sci. 2205: 69p.

Nelson, T.C., B.L. Nass, R.E. Bailey, and J.R. Irvine. 1994a. 1991 juvenile and adult coho salmon enumeration studies at Black Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2239: 71p.

Nelson, T.C., J.R. Irvine, and R.E. Bailey. 1994b. 1992 juvenile and adult coho salmon enumeration studies at Black Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2290: x+70p.

Nelson, T.C., R.E. Bailey, and J.R. Irvine. 1995. 1993 juvenile and adult coho salmon enumeration studies at Black Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2291: x+74p.

Nelson, T.C., J.R. Irvine, and R.E. Bailey. 1996. 1994 juvenile and adult coho salmon enumeration studies at Black Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2356: x+67p.

Nelson, T.C., and K.S. Simpson. 1996. 1995 juvenile coho salmon enumeration studies at Black Creek, Vancouver Island. Can. MS Rep. Fish. Aquat. Sci. 2361: ix +40p.

Perrin, C.J., and J.R. Irvine. 1990. A review of survey life estimates as they apply to the Area-Under-the-Curve method for estimating the spawning escapement of Pacific salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1733: 49p.

Schubert, N.D. 1982a. Trapping and coded wire tagging of wild coho salmon smolts from the Salmon River (Langley), 1978 to 1980. Can. MS Rep. Fish. Aquat. Sci. 1972: 68p.

Schubert, N.D. 1982b. A bio-physical inventory of thirty lower Fraser Valley streams. Can. MS Rep. Fish. Aquat. Sci. 1644: 130p.

Schubert, N.D., and A.Y. Fedorenko. 1985. Trapping and coded wire tagging of wild coho salmon juveniles in the upper Pitt River system, 1979 and 1980. Can. MS Rep. Fish. Aquat. Sci. 1815: 78p.

Schubert, N.D., M.K. Farwell, and L.W. Kalnin. 1994a. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1991 tag application and 1992-1993 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2208: 39p.

Schubert, N.D., M.K. Farwell, and L.W. Kalnin. 1994b. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1992 tag application and 1993-1994 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2241: 33p.

Schubert, N.D. and O. Fleming. 1989. An evaluation of the escapement and survival of selected lower Fraser River area wild coho salmon stocks. Can. MS Rep. Fish. Aquat. Sci. 2006: 121p.

Schubert, N.D. and L.W. Kalnin. 1990. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1986 tag application and 1987 spawner enumeration. Can. MS Rep. Fish. Aquat. Sci. 2053: 43p.

Seber, G.A.F., and E.D. LeCren. 1967. Estimating population parameters from catches large relative to the population. J. Anim. Ecol. 46: 631-643.

Simpson, K., B. Holtby, R. Kadowaki and W. Luedke. 1996. Assessment of coho stocks on the west coast of Vancouver Island. PSARC Working Paper S96-10.

Simpson, K., R. Diewert, R. Kadowaki, C. Cross, and S. Lehmann. 1997. A 1996 update of assessment information for Strait of Georgia coho salmon stocks (including the Fraser River). PSARC Working Paper S97-5.

Simpson, K. 1998. Assessment of west Vancouver Island coho,1997. PSARC Working Paper S98-7.

Solazzi, M.F., T.E. Nickelson, and S.L. Johnson. 1990. An evaluation of the use of coho salmon presmolts to supplement wild production in Oregon coastal streams. Oregon Dep. Fish. Wildl. Fish. Res. Rep. 10: 22p.

Symons, P.E.K. and M. Waldichuk [eds.]. 1984. Proceedings of the workshop on stream indexing for salmon escapement estimation. Can. Tech. Rep. Fish. Aquat. Sci. 1326: 273 p.

Whyte, I.W., N.D. Schubert and D.G. Hickey. 1987. An assessment of the fall Vedder-Chilliwack River sport fishery, 1986. Can. MS Rep. Fish. Aquat. Sci. 1928: 22p.

Whyte, I.W., and N.D. Schubert. 1990. An assessment of the fall Vedder-Chilliwack River sport fishery, 1988. Can. MS Rep. Fish. Aquat. Sci. 2050: 33p.

7 TABLES

Table 1. Numbers of coho fry per m of stream length in September, 1991 to 1998, from Georgia Basin sites. Data in the shaded areas were selected for analysis.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	Mean
Central East Vancouver Island (Area 13 adjacent to Str. of Georgia and Area 14)									
Bear			15.0	16.5	5.8	16.2	10.5	4.0	11.3
Black-1	9.0	22.8	15.4	7.0	13.7	19.1	2.1	5.7	11.9
Black-2						7.1	2.4		4.7
Black-3							2.9	5.3	4.1
Black-Millar					4.9	1.5	2.7	5.1	3.5
Chef-1		6.7	13.8	6.6	20.4	23.8	6.3	10.3	12.6
Chef-2						15.6	1.3	3.7	6.9
Cook	12.1	9.1	37.5	1.6					15.1
Cougar-1	6.7	2.5	5.0	5.9	10.5	7.4	8.0	5.3	6.4
Cougar-2						3.5	3.3	2.8	3.2
Kingfisher	6.3	1.3	1.1	3.5					3.1
Kitty Coleman			4.1	0.0					2.0
Menzies	5.8								5.8
Millard	5.0	3.3	1.0	5.5	3.2	4.6	2.5	1.4	3.3
Morrison-1			1.5	1.0		1.4	1.7	1.4	1.4
Morrison-2					3.3	5.3	1.4	2.4	3.1
Nile	28.8	10.3	6.1	2.1	5.9	6.7	3.6	7.1	8.8
Oyster		11.0							11.0
Portuguese			2.7	3.4	2.1	7.6	0.9	0.0	2.8
Rosewall			1.0	0.0					0.5
Waterloo	14.0	1.6	3.9	3.1	2.5	8.7	4.4	4.5	5.3
Willow-1					7.1	8.6	5.7	5.2	6.6
Willow-2						3.7	0.5	4.1	2.8
Area 13-14 Medians:									
All data	7.9	6.7	4.1	3.4	5.8	7.2	2.7	4.3	4.7
Selected data	9.0	3.3	4.1	3.4	5.3	6.9	2.7	4.3	3.8
South East Vancouver Island (Areas 17-19)									
Beck						3.1	1.4	0.3	1.6
Bings			6.4	5.2	9.8	6.3	4.6	6.9	6.5
Bush-1		7.8	14.0	11.6	8.6	15.9	0.5	2.0	8.6
Bush-2					32.0				32.0
Bush-3						6.0	5.2	5.3	5.5
Chase-1	4.4	4.4	3.1	2.0	2.0		1.2	1.7	2.7
Chase-2		18.7	16.0	12.9	10.9		9.7	7.7	12.6
Chase-3		4.6							4.6
Goldstream	4.8	8.1	0.7	1.5					3.8
Halfway-1	12.2	3.4	0.0	0.9	7.6	3.0	2.0	5.1	4.3
Halfway-2					6.6	12.4	4.0	4.1	6.8
Haslam						16.7	2.0	11.3	10.0
Head			2.8	6.3	10.5	8.3	8.6	5.3	7.0
Nanoose	3.7	4.8	6.4	10.0	10.4	10.2	2.8	8.1	7.0

Table 1 (continued). Fry Densities.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	Mean
Oliver-1		3.4	6.1	4.3	5.0	4.2	0.0	0.7	3.4
Oliver-2		4.2	11.1	12.0	3.9	11.4	2.0	0.7	6.5
Patricia			3.1	3.2	4.6	6.2	4.1	5.4	4.4
Richards-1			1.3	3.0	10.0	8.3	10.7	3.2	6.1
Richards-2							5.8	3.3	4.5
Whitehouse	10.2	6.6	15.2	8.6	8.3	9.5	2.1	2.0	7.8
Area 17-19 Medians:									
All data	4.8	4.7	6.1	5.2	8.4	8.3	2.8	4.1	6.3
Selected data	10.2	4.5	6.3	5.8	8.4	8.3	2.8	4.1	6.5
Sunshine Coast and Howe Sound (Areas 15-16 and 28)									
Angus		4.5	6.0	1.4	4.5				4.1
Branch 100					26.5	10.1	21.4	19.4	19.3
Chapman									
Chaster		4.6	2.7	2.4					3.2
Dryden				5.6					5.6
Hastings		2.2	7.7	2.4					4.1
Klein	5.2	14.7	5.6	6.8					8.1
Little Stawamus-1	7.6	8.1	8.5	8.4	10.1				8.5
Little Stawamus-2		41.8	31.8	21.9	17.1	26.8	14.4		25.6
Little Stawamus-3						3.9	12.1	2.6	6.2
Meighan	5.7	2.6	2.5	1.7					3.1
Mixal					0.9				0.9
Myers-1		8.2	0.8						4.5
Myers-2				4.9	3.1		2.9		3.6
Myers-3					5.4		4.0	2.5	4.0
Okeover-1	10.9	3.4	2.5	1.8	2.2		0.2	0.8	3.1
Okeover-2		3.7	0.2	0.0	3.9		0.5	0.8	1.5
Ouillet		2.7	5.1	1.0					2.9
Whittall	35.1	19.5	10.7	11.5	4.8		1.2	2.3	12.1
Wilson-1		1.8	0.7	0.4	2.8		1.0	2.4	1.5
Wilson-2					1.6		3.3	4.4	3.1
Area 15-16,28 Medians:									
All data	10.8	9.1	6.1	5.0	6.9	(13.6)	6.1	4.4	6.9
Selected data	9.3	8.2	4.0	5.9	3.9	(15.4)	2.9	2.4	4.2
Lower Mainland (Areas 29B-E)									
Little Campbell	4.8	2.5	2.4	1.1			1.2	5.4	2.9
Lorenzetta					2.6			15.1	8.9
MacIntyre		15.0	19.6	12.1	10.9	18.3	9.6		14.3
Murray	8.0	7.7	7.1	7.9	13.4	10.0	6.8	17.5	9.8
Nathan-1	6.8	3.8	9.3	8.6	5.4	11.5	4.1	4.9	6.8
Nathan-2		5.4	15.6	17.3	10.5	10.6	7.4	33.6	14.3

Table 1 (continued). Fry Densities.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	Mean
Post					5.3	3.7	6.0	4.6	4.9
Salmon - 248th St							4.7		4.7
Salmon - 56th St							5.8		5.8
Salmon - 64th Ave							2.1		2.1
Salmon-Coghlan-1	12.2	7.6	6.0	5.2	5.0	6.7	2.2	11.1	7.0
Salmon-Coghlan-2					13.9	7.3	7.2	5.5	8.5
Salmon-Coghlan-3							0.8		0.8
Siddle		11.6	26.7	22.2	19.6	11.4	14.7	11.4	16.8
Whonnock-1	2.6	2.5	6.7	3.0	5.4	4.9	5.1	4.5	4.3
Whonnock-2					4.1	6.8	4.6	3.3	4.7
Lower Mnld. Medians:									
All data	6.9	7.0	11.7	9.7	8.7	9.1	5.5	10.6	7.3
Selected data	7.4	6.5	8.2	8.2	5.4	7.3	5.1	5.5	6.3
All Data:									
Median	6.7	4.6	5.6	3.9	5.6	7.6	3.3	4.6	4.7
Mean of Area Medians	7.6	6.9	7.0	5.8	7.5	8.2	4.3	5.8	6.3
Selected Data:									
Median	8.5	5.4	6.1	5.5	5.4	7.3	3.3	4.4	5.4
Mean of Area Medians	9.0	5.6	5.6	5.8	5.8	7.5[2]	3.4	4.0	5.2

[1] Sites are numbered where more than one site was surveyed.
[2] Does not include the single stream in the Area 15,16,28 group.

Table 2. Fork lengths of coho fry in September, 1991 to 1998, from Georgia Basin sites. Data in the shaded areas were selected for analysis.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998[3]	Mean
Central East Vancouver Island (Area 13 adjacent to Str. of Georgia and Area 14)									
Bear			67.0	52.8	62.7	57.4	64.1	57.4	60.2
Black-1	50.5	57.0	61.4	60.0	50.8	57.7		59.5	56.7
Black-2						73.4	73.5		73.5
Black-3							60.0	55.4	57.7
Black-Millar					59.1	58.4	61.4	56.2	58.8
Chef-1		68.8	58.8	66.6	51.7	53.9	66.5	60.4	61.0
Chef-2						55.5	70.4	57.5	61.1
Cook	60.4	55.7	50.6	55.7					55.6
Cougar-1	66.6	70.2	62.1	65.5	60.6	64.8	59.5	65.6	64.4
Cougar-2						61.5	69.8	65.0	65.4
Kingfisher	72.4	76.2	87.6	74.4					77.7
Kitty Coleman			85.7						85.7
Menzies	71.9								71.9
Millard	63.2	72.1	80.1	64.6	72.0	71.1	74.4	76.1	71.7
Morrison-1			68.7	72.1		67.1	70.9	69.3	69.6
Morrison-2					63.5	55.6	64.0	59.9	60.7
Nile	67.1	59.1	58.8	68.1	58.8	62.0	71.7	63.2	63.6
Oyster		82.1							82.1
Portuguese			83.3	80.5	87.0	76.0	83.4	91.0	83.5
Rosewall			77.2	69.9					73.6
Waterloo	67.0	79.2	60.2	64.9	70.1	58.1	63.2	63.2	65.7
Willow-1					65.2	65.4	62.6	71.0	66.0
Willow-2						69.8	80.8	61.6	70.7
Area 13-14 Means:									
All data	64.9	68.9	69.4	66.3	63.8	63.0	68.5	64.5	67.7
Selected data	62.9	67.5	69.7	66.1	65.0	64.2	68.5	65.3	67.1
South East Vancouver Island (Areas 17-19)									
Beck						63.7	65.0	63.4	64.0
Bings			59.7	59.0	57.4	61.6	62.5	55.4	59.3
Bush-1		70.6	54.5	55.0	66.4	57.2	80.3	63.2	63.9
Bush-2					56.2				56.2
Bush-3						51.9	59.0	52.3	54.4
Chase-1	58.4	60.6	61.7	61.5	59.8		66.6	56.7	60.8
Chase-2		60.0	62.8	61.1	57.2		68.8	58.4	61.4
Chase-3		56.5							56.5
Goldstream	82.6	77.2	80.4	75.5					78.9
Halfway-1	47.6	57.8		65.4	48.8	61.2	72.1	50.7	57.7
Halfway-2					48.5	60.6	68.7	56.1	58.5
Haslam						59.9	65.2	60.4	61.8
Head			61.2	61.0	59.3	65.3	73.4	67.5	64.6
Nanoose	69.3	59.4	63.8	57.5	60.4	59.2	70.6	61.3	62.7
Oliver-1		50.5	52.1	50.6	52.1	59.9		61.5	54.5

Table 2 (continued). Fry Sizes.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998[3]	Mean
Oliver-2		63.6	66.8	65.8	59.9	67.8	61.8	66.0	64.5
Patricia			57.4	55.9	51.5	53.9	63.1	53.3	55.9
Richards-1			58.0	54.1	57.1	58.1	58.5	52.4	56.4
Richards-2							59.3	49.4	54.4
Whitehouse	59.4	63.9	56.0	55.0	56.8	56.6	69.1	66.8	60.5
Area 17-19 Means:									
All data	63.5	62.0	61.2	59.8	56.5	59.8	66.5	58.5	60.3
Selected data	58.8	61.0	58.8	57.9	56.2	59.8	66.3	58.6	59.3
Sunshine Coast and Howe Sound (Areas 15-16 and 28)									
Angus		67.4	69.2	63.8	61.1				65.4
Branch 100					45.1	50.2	48.3		47.9
Chapman	74.3								74.3
Chaster		70.0	78.7	76.1					74.9
Dryden				60.3					60.3
Hastings		65.1	60.6	61.7					62.5
Klein	62.8	65.2	68.1	70.3					66.6
Little Stawamus-1	50.4	56.1	58.9	49.3	55.1				53.9
Little Stawamus-2		58.0	59.3	55.6	50.9	57.2	53.5		55.8
Little Stawamus-3						59.2	59.8		59.5
Meighan	55.0	54.7	58.9	55.0					55.9
Mixal					58.5				58.5
Myers-1		68.3	71.2						69.7
Myers-2				54.4	53.1				53.7
Myers-3					63.6			56.9	60.3
Okeover-1	62.4	67.0	74.3	73.2	69.8			73.8	70.1
Okeover-2		59.1	67.7	62.0	51.1			58.7	59.7
Ouillet		71.8	68.2	64.6					68.2
Whittall	50.7	64.2	63.1	63.2	75.1			63.5	63.3
Wilson-1		74.1	78.8	80.1	58.8			56.7	69.7
Wilson-2					62.9		56.3	51.7	57.0
Area 15,16,28 Means:									
All data	59.3	64.7	67.5	63.5	58.8	55.5	54.5	60.2	62.2
Selected data	56.6	64.0	67.7	63.5	60.0	(58.2)	56.5	60.2	61.6
Lower Mainland (Areas 29B-E)									
Little Campbell	65.6	67.3	72.4	62.6			75.9		68.8
Lorenzetta					74.0				74.0
MacIntyre		53.7	51.2	51.9	53.5	48.6	53.6		52.1
Murray	74.0	56.1	69.0	51.8	57.7	65.0	76.2		64.2
Nathan-1	74.4	74.1	76.7	76.7	85.6	69.3	83.5		77.2
Nathan-2		68.0	58.8	57.5	61.4	65.1	72.7		63.9
Post					60.4	53.5	55.3		56.4

Table 2 (continued). Fry Sizes.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998[3]	Mean
Salmon - 248th St							77.6		77.6
Salmon - 56th St							69.8		69.8
Salmon - 64th Ave							71.7		71.7
Salmon-Coghlan-1	57.2	65.6	66.2	58.6	66.0	60.1	79.2		64.7
Salmon-Coghlan-2					57.6	58.5	68.6		61.6
Salmon-Coghlan-3							71.7		71.7
Siddle		53.0	48.6	51.2	53.8	51.7	56.9		52.5
Whonnock-1	63.6	65.1	61.4	71.0	63.9	57.8	76.0		65.5
Whonnock-2					51.1	48.5	53.0		50.8
Lower Mnld. Means:									
All data	67.0	62.8	63.0	60.2	62.3	57.8	69.4		65.2
Selected data	67.3	63.7	63.9	61.3	63.1	58.5	69.9		65.8
All Data:									
Grand Mean	63.6	64.6	65.6	62.6	60.1	60.2	67.1	61.2	63.9
Mean of Area Means	63.6	64.6	65.3	62.4	60.3	59.0	64.7	61.1	63.9
Selected Data:									
Grand Mean	61.6	63.9	65.0	62.0	60.9	61.0	67.4	61.6	63.5
Mean of Area Means	61.4	64.1	65.0	62.2	61.1	60.8	65.3	61.4	63.5

[1] Sites are numbered where more than one site was surveyed.

[2] Does not include the single stream in the Area 15,16,28 group.

[3] Size data are not yet available from Lower Mainland streams.

Table 3. Coho smolt production from Black Creek, 1985 to 1996 brood years: numbers by age and numbers per female spawner.

Brood Year	Females	Smolts			Total smolts per female
		Age 1.	Age 2.	Total	
1985	2,848	66,543	3,850	70,393	24.7
1986	2,420	73,150	4,667	77,817	32.2
1987	346	25,834	9,765	35,598	103.0
1988	1,267	109,317	3,905	113,222	89.3
1989	1,627	51,095	4,424	55,519	34.1
1990	713	45,847	9,515	55,362	77.6
1991	1,849	55,656	2,661	58,317	31.5
1992	815	75,610	4,980	80,590	98.9
1993	389	15,020	99	15,119	38.8
1994	419	14,079	1,608	15,687	37.5
1995	910	74,984	3,414	78,397	86.2
1996	126	21,324	-	21,324	169.2[1]

[1] Not including age 2. smolts (leaving spring, 1999)

Table 4. Key to catch region abbreviations.

NTR	Northern BC Troll	GSN	Str. of Georgia Net
NCTR	North/Central BC Troll	FGN	Fraser R. Gillnet
SCTR	South/Central BC Troll	JFN	Juan de Fuca Str. Net
NWTR	NW Vancouver Is. Troll	FSN	Fraser Seine Net
SWTR	SW Vancouver Is. Troll	NSPT	Northern BC Sport
GSTR	Str. of Georgia Troll	CSPT	Central BC Sport
JFTR	Juan de Fuca Str. Troll	ACSP	Alberni Canal Sport
NN	Northern BC Net	WSPT	West Coast Vancouver Is. Sport
CN	Central BC Net	GSPTN	Str. of Georgia Sport, North
NWVN	NW Vancouver Is. Net	GSPTS	Str. of Georgia Sport, South
SWVN	SW Vancouver Is. Net	JFSP	Juan de Fuca Str. Sport
JSN	Johnstone Str. Net	FWSP	Freshwater Sport

Table 5. Ocean catches of southern BC coho salmon in commercial and recreational fisheries by catch region and year,1970-1998. Catch region abbreviations are explained in Table 4.

YEAR	SCTR	GSTR	JFTR	SWTR	NWTR	FGN	FSN	Fraser Net[1]	JSN	GSN	JFN	SWVN	NWVN
1970	262,330	162,103	16,789	526,594	252,839	99,076	0	99,076	190,041	20,157	463,978	6,018	22,013
1971	134,687	238,985	7,130	1,509,385	666,334	70,636	145	70,781	226,741	26,663	597,689	10,317	30,967
1972	194,910	62,881	7,434	601,387	387,038	80,922	0	80,922	73,636	11,841	158,261	9,917	23,723
1973	171,408	92,497	1,508	1,127,748	278,553	53,521	0	53,521	145,999	17,357	474,034	13,437	23,608
1974	179,855	148,074	5,664	1,230,483	413,520	26,144	20	26,164	106,485	16,026	437,892	2,572	63,890
1975	115,696	112,609	4,094	524,507	256,741	43,226	12	43,238	116,468	21,401	408,213	4,041	72,406
1976	372,286	80,635	3,365	1,136,783	503,476	13,915	94	14,009	204,552	12,174	248,510	11,047	28,736
1977	159,925	143,194	7,314	1,244,496	323,383	41,427	692	42,119	226,896	11,510	505,842	9,636	41,160
1978	205,822	326,372	1,831	955,328	404,946	51,002	0	51,002	199,830	6,846	104,174	26,219	3,114
1979	186,351	224,239	1,496	1,365,077	547,801	7,661	0	7,661	135,435	1,142	255,340	23,057	2,321
1980	212,457	150,819	2,202	1,325,602	412,868	34,587	0	34,587	167,641	6,911	158,611	12,019	3,151
1981	196,917	63,867	5,270	1,026,915	358,408	5,181	0	5,181	201,216	12,353	278,186	6,319	1,073
1982	145,783	115,693	1,593	1,315,815	461,621	19,365	0	19,365	194,242	9,021	127,641	3,949	9,451
1983	351,635	57,938	0	1,689,250	478,188	11,302	21	11,323	243,265	16,279	16,907	9,053	155
1984	226,130	80,416	3,642	1,668,409	503,757	9,194	0	9,194	119,104	13,563	74,851	7,787	2,772
1985	89,266	191,207	310	1,012,020	377,035	18,229	0	18,229	147,276	31,764	224,735	4,859	2,656
1986	430,083	181,419	2,892	1,546,331	610,502	32,790	1,604	34,394	126,711	16,237	202,501	6,709	3,872
1987	141,049	217,538	190	1,295,914	525,108	6,528	0	6,528	60,746	14,045	216,400	6,741	501
1988	145,363	256,480	187	1,039,887	555,914	26,899	2,994	29,893	84,306	3,478	56,719	10,968	0
1989	94,888	73,306	69	1,373,216	578,793	9,954	0	9,954	116,300	5,051	342,055	39,660	0
1990	165,128	163,202	92	1,134,092	729,516	12,748	0	12,748	106,638	8,014	154,133	2,740	0
1991	47,384	11,583	0	1,225,300	664,646	10,085	6	10,091	70,292	7,168	180,362	5,234	0
1992	164,425	137,289	0	736,329	935,493	6,963	0	6,963	76,073	5,675	105,963	9,167	572
1993	56,726	275,953	0	531,812	421,999	3,000	0	3,000	58,356	7,216	6,211	3,406	71
1994	36,074	50,754	0	1,044,142	207,675	5,664	0	5,664	37,574	716	131,026	4,661	91
1995	6,369	15	0	1,076,442	277,561	832	0	832	17,856	19	38,166	1,470	74
1996	1,944	21	720	555,227	237,349	874	0	874	5,517	0	4,155	1,013	0
1997	1,001	19	0	3	35	753	0	753	5,913	0	402	10	3
1998	0	0	0	0	0	0	0	0	5	0	122	0	0

[1] FGN plus FSN

Table 5 (continued) Coho catches.

GSPN	GSPS	JFSP	GS Sport+ JFSP[2]	ACSP	WSPT	WVI Sport[3]	Gear Totals Net	Gear Totals Troll	Gear Totals Sport	Grand Total
			500,000				801,283	1,220,655	500,000	2,521,938
			800,000				963,158	2,556,521	800,000	4,319,679
			335,000				358,300	1,253,650	335,000	1,946,950
			373,000				727,956	1,671,714	373,000	2,772,670
			772,000				653,029	1,977,596	772,000	3,402,625
			454,000				665,767	1,013,647	454,000	2,133,414
			415,000				519,028	2,096,545	415,000	3,030,573
			682,000				837,163	1,878,312	682,000	3,397,475
			1,103,000				391,185	1,894,299	1,103,000	3,388,484
			708,734				424,956	2,324,964	708,734	3,458,654
291,200	86,600	15,700	393,500				382,920	2,103,948	393,500	2,880,368
219,626	72,210	25,255	317,091				504,328	1,651,377	317,091	2,472,796
333,700	57,996	19,990	411,686				363,669	2,040,505	411,686	2,815,860
310,246	52,420	41,365	404,031				296,982	2,577,011	404,031	3,278,024
318,302	83,462	41,826	443,590	2,995		2,995	227,271	2,482,354	446,585	3,156,210
569,722	133,171	25,304	728,197	628	1,562	2,190	429,519	1,669,838	730,387	2,829,744
442,432	94,842	34,706	571,980	1,458	1,121	2,579	390,424	2,771,227	574,559	3,736,210
472,127	107,886	61,559	641,572	2,215	24,619	26,834	304,961	2,179,799	668,406	3,153,166
824,298	184,614	75,878	1,084,790	303	5,323	5,626	185,364	1,997,831	1,090,416	3,273,611
332,647	75,149	89,427	497,223	816	44,452	45,268	513,020	2,120,272	542,491	3,175,783
493,105	67,519	69,409	630,033	334	19,843	20,177	284,273	2,192,030	650,210	3,126,513
34,977	11,544	110,590	157,111	239	49,847	50,086	273,147	1,948,913	207,197	2,429,257
358,494	117,328	119,732	595,554	195	37,459	37,654	204,413	1,973,536	633,208	2,811,157
552,115	177,698	108,918	838,731	587	13,735	14,322	78,260	1,286,490	853,053	2,217,803
147,991	28,159	118,617	294,767	19	16,378	16,397	179,732	1,338,645	311,164	1,829,541
11,208	3,476	71,461	86,145	416	41,155	41,571	58,417	1,360,387	127,716	1,546,520
26,737	7,139	94,014	127,890	564	25,148	25,712	11,559	795,261	153,602	960,422
2,620	2,786	105,063	110,469	529	29,052	29,581	7,081	1,058	140,050	148,189
128	1,219	69	1,416	0	0	0	127	0	1,416	1,543

[2] Total of GSPN, GSPS AND JFSP. [3] ACSP plus WSPT

Table 6. Expanded CWT recoveries by catch region for adult coho released from Quinsam Hatchery, 1977 to 1998. Escapements, survivals, exploitations and 'inside' catch distributions are also given.

Return Year:	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
No.Smolts Rel'd:	1,439,951	661,667	447,803	1,331,237	1,066,444	714,197	740,626	948,180	1,174,047	1,853,852	1,201,640	1,287,066
Fishery:												
NTR	178	751	79	980	305	113	161	114	57	379	382	540
NCTR	1,163	1,018	164	2,332	546	236	555	191	114	331	642	581
SCTR	3,690	5,735	1,593	13,158	10,973	2,746	8,794	5,333	4,510	24,835	5,760	6,946
NWTR	2,333	3,186	1,413	8,084	3,909	2,497	4,792	3,885	2,745	4,775	4,080	8,805
SWTR	2,516	1,699	791	5,311	2,317	1,472	1,226	2,571	2,421	3,115	2,534	1,444
GSTR	2,924	6,009	1,154	7,415	1,639	1,200	2,897	1,388	3,886	5,587	13,307	6,480
JFTR	-	-	-	-	-	-	-	-	-	-	-	-
NN	25	-	227	198	-	31	-	-	24	-	95	-
CN	24,730	880	499	1,497	116	379	238	86	348	165	308	468
NWVN	1,531	-	-	-	-	-	-	4	-	25	-	-
SWVN	-	-	-	110	15	-	-	-	31	-	-	-
JSN	19,137	10,066	3,677	23,104	20,679	7,970	12,042	7,229	16,792	17,258	6,011	12,218
GSN	78	35	-	57	155	55	125	111	218	461	169	176
FGN	-	65	15	19	139	39	69	48	12	145	-	-
JFN	758	31	23	757	1,038	181	26	71	852	773	744	263
FSN	-	-	-	-	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-	6	-	-	-
CSPT	164	216	181	786	618	320	581	593	864	2,326	850	2,395
ACSP	-	-	-	-	-	-	-	-	-	26	-	-
WSPT	-	-	-	70	-	-	109	34	7	15	601	-
GSPTN	26,069	20,160	10,088	35,326	12,696	5,188	8,275	10,442	35,894	29,275	39,065	37,246
GSPTS	530	746	488	1,088	448	220	419	745	1,005	1,825	1,522	863
JFSP	88	189	29	-	-	-	96	159	180	353	643	1,112
FWSP	-	-	-	-	-	-	36	95	355	110	179	232
WASHINGTON	935	326	163	1,591	1,284	321	256	206	1,112	1,086	1,050	84
ALASKA	-	-	25	748	37	101	-	32	19	193	-	-
TOTAL BC TROLL	12,804	18,398	5,195	37,279	19,688	8,264	18,425	13,482	13,732	39,022	26,705	24,795
TOTAL BC NET	46,258	11,078	4,440	25,742	22,141	8,654	12,500	7,549	18,277	18,826	7,325	13,125
TOTAL BC SPORT	26,851	21,311	10,787	37,270	13,762	5,728	9,516	12,068	38,310	33,930	42,860	41,847
ESCAPEMENT	16,613	13,118	8,363	23,239	17,779	8,875	12,011	16,242	21,549	33,949	17,364	22,405
% SURVIVAL	7.2	9.7	6.5	9.5	7.0	4.5	7.1	5.2	7.9	6.9	7.9	7.9
% EXPLOITATION[1]	83.9	79.6	71.1	81.5	76.2	72.2	77.2	67.2	76.8	73.3	81.8	78.1
% MARINE EXPLOIT'N[2]	83.9	79.6	71.1	81.5	76.2	72.2	77.1	67.0	76.4	73.2	81.6	77.9
% INSIDE[3]	34.4	53.0	57.4	43.4	26.6	29.1	28.7	38.1	58.3	39.9	70.3	56.1

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as proportions of total marine recoveries, excluding recoveries from Washington.

Table 6 (continued). Quinsam Hatchery.

Return Year:	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No.Smolts Rel'd:	1,347,697	1,057,725	1,172,118	1,176,616	1,220,201	1,224,754	1,128,936	1,193,987	1,215,267	1,249,119
Fishery:										
NTR	867	143	139	-	-	-	-	-	33	-
NCTR	92	-	56	212	-	-	-	-	-	-
SCTR	4,218	3,846	558	4,695	646	351	-	-	-	-
NWTR	8,081	3,546	5,834	6,330	1,151	1,734	3,252	951	-	-
SWTR	3,839	1,473	11,045	1,156	182	6,024	7,388	1,711	-	-
GSTR	13,372	10,244	540	6,191	4,891	1,482	-	-	-	-
JFTR	-	-	-	-	-	-	-	-	-	-
NN	4	65	-	-	-	-	-	-	-	-
CN	408	219	-	327	-	94	-	-	111	-
NWVN	-	-	-	-	-	-	-	-	-	-
SWVN	575	-	-	-	-	54	21	-	-	-
JSN	16,453	11,139	4,309	4,852	3,391	985	827	473	1,080	-
GSN	112	122	155	-	-	-	-	-	-	-
FGN	14	-	-	-	-	-	-	-	22	-
JFN	2,073	836	2,628	224	-	571	851	-	-	-
FSN	-	-	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-	-	-
CSPT	1,845	1,432	1,208	3,524	854	133	-	554	768	-
ACSP	-	-	-	-	-	-	-	-	-	-
WSPT	30	-	590	-	-	296	916	988	43	-
GSPTN	39,383	32,784	3,004	23,875	20,474	7,300	1,663	1,074	94	-
GSPTS	3,055	1,746	-	2,602	446	698	-	-	182	-
JFSP	637	440	408	330	-	509	993	634	2,394	-
FWSP	33	275	-	-	-	-	-	-	-	-
WASHINGTON	1,523	141	2,309	326	-	67	1,188	205	670	89
ALASKA	316	178	-	-	-	68	-	141	-	214
TOTAL BC TROLL	30,467	19,252	18,173	18,584	6,870	9,591	10,640	2,662	33	-
TOTAL BC NET	19,638	12,381	7,092	5,403	3,391	1,704	1,699	473	1,213	-
TOTAL BC SPORT	44,984	36,676	5,209	30,330	21,773	8,935	3,571	3,250	3,481	-
ESCAPEMENT	40,484	13,782	16,209	14,538	10,261	7,329	11,133	9,671	8,400	11,610
% SURVIVAL	10.2	7.8	4.2	5.9	3.5	2.3	2.5	1.4	1.1	1.0
% EXPLOITATION[1]	70.5	83.3	66.9	79.0	75.7	73.5	60.6	41.0	39.1	2.5
% MARINE EXPLOIT'N[2]	70.5	82.9	66.9	79.0	75.7	73.5	60.6	41.0	39.1	2.5
% INSIDE[3]	58.5	65.6	11.6	60.1	80.6	46.7	10.4	16.5	5.8	0.0

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 7. Expanded CWT recoveries by catch region for adult coho released from Big Qualicum Hatchery, 1976 to 1998. Escapements, survivals, exploitations and 'inside' catch distributions are also given.

Return Year:	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
No.Smolts Rel'd:	377,765	672,372	783,081	837,830	615,242	750,195	1,197,409	1,182,746	1,169,263	1,254,712	3,450,163	2,591,461
Fishery:												
NTR	290	112	372	336	425	-	79	-	293	-	-	-
NCTR	1,492	493	1,680	510	637	946	497	381	334	-	-	-
SCTR	11,205	2,826	8,499	5,000	6,695	9,109	5,719	20,743	7,552	1,101	2,323	8
NWTR	4,694	2,233	6,748	3,772	6,703	4,754	4,426	9,579	10,032	2,164	1,214	1,611
SWTR	7,609	5,422	6,948	6,059	9,665	7,877	14,073	6,887	9,048	4,218	4,678	1,288
GSTR	6,448	6,690	12,726	16,145	14,896	4,771	11,981	970	3,609	5,111	3,741	1,787
JFTR	-	30	-	-	-	-	-	-	-	-	-	-
NN	94	93	-	160	-	-	-	-	-	-	-	-
CN	1,990	7,847	1,340	853	521	359	321	668	-	200	-	-
NWVN	91	126	-	-	-	-	163	-	-	-	-	-
SWVN	23	-	131	-	12	22	-	-	73	-	-	-
JSN	11,763	14,999	16,969	9,195	14,989	12,024	18,681	19,380	7,084	4,818	1,264	765
GSN	3,005	787	331	-	435	1,144	2,204	6,850	3,833	6,296	1,043	730
FGN	297	-	278	208	-	-	93	24	-	-	-	-
JFN	2,173	1,622	568	833	1,268	1,317	1,083	44	516	1,589	538	431
FSN	-	-	-	-	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-	-	-	-	-
CSPT	26	71	-	346	259	140	675	502	668	187	-	333
ACSP	-	-	-	-	-	-	-	-	-	-	-	-
WSPT	-	-	35	-	-	-	86	-	-	-	-	-
GSPTN	35,933	30,251	23,117	65,071	64,408	19,123	27,521	35,186	16,440	23,205	9,135	6,461
GSPTS	2,661	3,036	3,504	6,895	7,321	2,118	3,144	2,637	1,630	1,772	188	327
JFSP	289	292	185	275	102	282	1,041	715	662	114	198	376
FWSP	-	-	-	-	-	-	-	72	276	490	-	310
WASHINGTON	7,448	2,487	2,490	1,172	9,875	2,112	5,825	2,028	601	1,564	2,103	118
ALASKA	213	-	-	213	-	-	253	-	200	-	-	-
TOTAL BC TROLL	31,737	17,805	36,973	31,822	39,021	27,457	36,775	38,561	30,869	12,593	11,956	4,694
TOTAL BC NET	19,435	25,473	19,618	11,249	17,226	14,866	22,546	26,966	11,506	12,903	2,845	1,926
TOTAL BC SPORT	38,910	33,650	26,841	72,587	72,090	21,662	32,468	39,112	19,676	25,768	9,521	7,807
ESCAPEMENT	9,157	30,715	33,126	44,351	38,204	29,262	25,363	25,086	29,265	10,076	9,100	5,217
% SURVIVAL	28.3	16.4	15.2	19.3	28.7	12.7	10.3	11.1	7.9	5.0	1.0	0.8
% EXPLOITATION[1]	91.4	72.1	72.2	72.5	78.3	69.3	79.4	81.0	68.2	84.0	74.4	73.6
% MARINE EXPLOIT'N[2]	91.4	72.1	72.2	72.5	78.3	69.3	79.4	80.9	67.9	83.2	74.4	72.0
% INSIDE[3]	49.9	52.0	47.2	76.0	67.5	40.7	46.3	37.1	35.0	59.3	53.7	60.7

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 7 (continued). Big Qualicum Hatchery.

Return Year:	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No.Smolts Rel'd:	1,423,982	1,008,692	701,855	1,016,919	1,062,989	1,142,312	1,168,887	1,158,714	1,391,025	1,302,866	1,278,697
Fishery:											
NTR	-	-	-	-	-	181	-	-	451	-	-
NCTR	80	-	-	-	198	-	-	-	-	-	-
SCTR	1,620	-	1,077	594	1,479	824	62	178	-	-	-
NWTR	1,264	350	2,126	8,050	6,878	2,349	4,822	4,416	4,439	-	-
SWTR	15	1,298	862	17,677	3,393	834	19,082	10,927	5,199	-	-
GSTR	1,465	332	3,062	327	5,869	11,502	2,598	-	-	-	-
JFTR	-	-	-	-	-	-	-	-	-	-	-
NN	-	-	-	-	-	-	-	-	-	-	-
CN	5	-	54	-	275	-	-	-	-	-	-
NWVN	-	-	-	-	-	-	-	-	-	-	-
SWVN	-	-	-	209	114	37	149	43	-	-	-
JSN	2,150	598	1,591	1,115	4,041	3,115	895	392	321	442	-
GSN	842	251	918	2,909	826	626	324	-	-	-	-
FGN	-	147	-	-	-	31	-	-	-	-	-
JFN	194	712	805	2,767	591	-	3,650	123	-	-	-
FSN	-	-	-	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-	-	-	-
CSPT	599	-	256	881	1,419	1,092	307	104	-	621	-
ACSP	-	-	-	-	-	-	-	-	-	-	-
WSPT	-	-	1,011	480	-	-	1,099	1,069	651	335	-
GSPTN	10,230	4,479	9,820	4,299	19,097	32,343	15,708	354	594	493	-
GSPTS	538	-	680	-	2,073	2,790	1,239	64	-	-	-
JFSP	-	-	562	994	508	123	1,995	422	-	2,719	-
FWSP	-	-	193	239	148	335	2,270	316	533	260	103
WASHINGTON	167	90	916	4,819	400	126	-	363	317	1,264	34
ALASKA	136	-	-	65	-	110	-	163	79	-	63
TOTAL BC TROLL	4,444	1,980	7,127	26,648	17,817	15,690	26,564	15,521	10,089	-	-
TOTAL BC NET	3,191	1,708	3,367	7,000	5,846	3,808	5,018	557	321	442	-
TOTAL BC SPORT	11,367	4,479	12,521	6,893	23,246	36,681	22,618	2,329	1,777	4,427	103
ESCAPEMENT	4,758	5,201	10,660	20,263	14,811	19,775	25,811	15,115	8,608	12,065	1,716
% SURVIVAL	1.7	1.3	4.9	6.5	5.8	6.7	6.8	2.9	1.5	1.4	0.3 [4]
% EXPLOITATION[1]	80.2	61.4	69.2	69.2	76.2	74.0	67.7	55.6	59.4	33.7	19.7 [4]
% MARINE EXPLOIT'N[2]	80.2	61.4	68.6	68.8	75.9	73.6	64.9	54.7	56.9	32.3	9.0 [4]
% INSIDE[3]	63.9	58.9	59.4	11.5	57.8	83.3	37.6	2.3	5.1	10.7	0.0

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington. [4] Recoveries include pelvic fin clip (P) coho but they were excluded for survival and exploitation calculations. See Table for a breakdown of P and no-P releases.

Table 8. Expanded CWT recoveries by catch region for adult coho released from Inch Hatchery, 1985 to 1998. Escapements, survivals, exploitations and 'inside' catch distributions are also given.

Return Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
No.Smolts Rel'd:	70,595	80,268	99,414	53,863	59,721	82,129	184,526	153,120	183,104	229,647	242,949	257,049
Fishery:												
NTR	-	-	43	-	-	-	-	-	-	-	-	-
NCTR	5	-	-	-	8	-	-	91	-	-	-	-
SCTR	-	162	149	41	29	32	18	194	18	-	-	-
NWTR	105	141	269	193	51	260	1,092	1,493	311	529	666	1,374
SWTR	759	557	1,007	786	999	1,289	5,262	2,083	575	5,533	6,903	4,642
GSTR	964	1,026	1,565	2,308	277	775	180	1,901	3,387	1,130	-	-
JFTR	-	-	-	-	-	-	-	-	-	-	-	-
NN	-	-	-	-	-	-	-	-	-	-	-	-
CN	-	-	-	-	-	-	-	-	-	-	62	-
NWVN	-	-	-	-	-	-	-	-	-	-	-	-
SWVN	-	3	31	23	69	-	21	26	-	61	-	-
JSN	28	56	111	127	40	72	-	121	123	10	154	-
GSN	47	18	46	18	-	11	-	13	14	-	-	-
FGN	15	63	-	106	-	102	359	193	-	27	-	-
JFN	170	104	240	33	434	250	811	209	-	1,075	295	29
FSN	-	8	-	-	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-	-	-	-	-
CSPT	-	12	46	22	-	46	25	47	63	-	-	-
ACSP	-	-	-	-	-	-	-	-	-	-	-	-
WSPT	-	-	5	-	-	-	-	-	-	20	121	-
GSPTN	1,406	974	2,224	3,982	1,241	1,559	173	2,647	5,148	2,113	112	307
GSPTS	554	364	793	1,498	466	494	581	1,542	1,926	438	1,165	312
JFSP	19	16	89	103	69	127	225	268	98	335	256	577
FWSP	28	15	28	85	59	11	69	21	76	105	124	359
WASHINGTON	286	305	431	358	669	614	1,598	522	249	31	471	560
ALASKA	-	-	-	-	-	-	9	-	-	-	-	-
TOTAL BC TROLL	1,833	1,885	3,032	3,328	1,365	2,356	6,551	5,762	4,290	7,193	7,569	6,016
TOTAL BC NET	259	253	429	307	544	435	1,191	563	137	1,174	511	29
TOTAL BC SPORT	2,007	1,380	3,184	5,689	1,834	2,236	1,072	4,525	7,312	3,010	1,777	1,554
ESCAPEMENT	451	970	1,350	1,233	2,074	902	2,594	3,581	3,216	2,486	3,027	1,790
% SURVIVAL	6.8	6.0	8.5	20.3	10.9	8.0	7.1	9.8	8.3	6.0	5.5	3.9
% EXPLOITATION[1]	90.7	79.8	84.0	88.7	68.0	86.2	80.1	76.1	78.8	82.1	77.3	82.0
% MARINE EXPLOIT'	90.1	79.5	83.6	87.9	67.1	86.0	79.5	75.9	78.3	81.3	76.4	78.4
% INSIDE[3]	71.8	67.5	69.2	84.3	53.8	56.4	10.7	56.2	89.7	32.7	13.1	8.5

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 8 (continued). Inch Hatchery.

Return Year:	1997	1998
No.Smolts Rel'd:	231,092	477,089
Fishery:		
NTR	-	-
NCTR	-	-
SCTR	-	-
NWTR	-	-
SWTR	-	-
GSTR	-	-
JFTR	-	-
NN	-	-
CN	-	-
NWVN	-	-
SWVN	-	-
JSN	13	13
GSN	-	-
FGN	-	-
JFN	-	-
FSN	-	-
NSPT	-	-
CSPT	-	-
ACSP	-	-
WSPT	-	-
GSPTN	-	-
GSPTS	-	8
JFSP	105	-
FWSP	100	385
WASHINGTON	601	63
ALASKA	-	14
TOTAL BC TROLL	-	-
TOTAL BC NET	13	13
TOTAL BC SPORT	205	393
ESCAPEMENT	1,519	1,771
% SURVIVAL	1.0	0.5 [4]
% EXPLOITATION[1]	35.0	16.9 [4]
% MARINE EXPLOIT'	30.7	9.6 [4]
% INSIDE[3]	0.0	23.9

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington. [4] Recoveries include pelvic fin clip (P) coho but they were excluded for survival and exploitation calculations. See Table 15 for a breakdown of P and no-P releases.

Table 9. Expanded CWT recoveries by catch region for adult coho released from Chilliwack Hatchery, 1983 to 1998. Escapements, survivals and 'inside' catch distributions are also given. Survivals are calculated from Inch Hatchery exploitation rates (see text).

Return Year:	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
No.Smolts Rel'd:	59,358	31,516	393,925	2,119,869	1,788,359	1,799,232	1,706,288	1,728,963	1,828,481	1,908,265	1,942,508	2,083,037
Fishery:												
NTR	40	-	63	-	1,243	165	222	253	219	-	-	-
NCTR	37	15	19	237	107	158	73	122	-	-	-	-
SCTR	547	100	300	4,498	5,229	2,819	318	2,286	671	1,895	247	101
NWTR	365	265	2,091	8,019	16,526	9,694	10,406	14,006	20,098	13,624	6,595	12,139
SWTR	882	921	6,308	36,011	41,518	20,494	40,253	26,948	57,429	12,413	11,142	54,045
GSTR	397	348	11,822	31,361	40,098	53,645	8,083	22,944	235	11,127	22,425	3,221
JFTR	-	1	-	-	-	-	-	-	-	-	-	-
NN	5	-	-	132	-	-	-	-	-	-	-	-
CN	13	-	11	73	49	-	-	-	-	-	-	-
NWVN	-	-	-	-	-	-	-	-	-	-	-	-
SWVN	-	-	18	-	168	490	2,192	-	-	140	56	4
JSN	623	79	959	1,516	2,307	4,833	2,676	2,653	1,300	1,983	1,175	303
GSN	53	6	537	792	876	168	-	190	-	151	390	-
FGN	80	18	1,056	3,935	1,774	7,418	1,355	2,201	825	451	605	603
JFN	15	32	1,042	3,040	8,017	1,086	14,513	6,377	8,983	2,407	210	3,487
FSN	-	-	-	541	-	211	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-	-	-	-	-
CSPT	20	-	43	277	239	2,101	218	-	338	-	465	256
ACSP	-	-	-	-	-	-	-	-	-	-	-	-
WSPT	-	4	-	247	1,077	-	1,251	741	899	1,011	-	887
GSPTN	1,259	471	16,908	39,078	68,712	116,550	35,878	40,905	1,526	20,182	34,261	12,396
GSPTS	373	226	4,600	8,924	15,871	28,480	14,264	6,378	1,767	6,452	6,285	2,182
JFSP	27	13	129	1,292	2,800	1,963	1,903	1,293	1,878	831	190	2,920
FWSP	429	137	1,705	9,830	9,701	7,825	11,713	6,413	4,503	2,071	5,422	5,192
WASHINGTON	312	101	4,635	15,996	17,726	12,944	19,583	7,405	19,610	2,381	4,166	846
ALASKA	15	4	11	-	80	-	69	-	111	-	-	153
TOTAL BC TROLL	2,269	1,649	20,604	80,125	104,721	86,974	59,355	66,559	78,652	39,060	40,409	69,506
TOTAL BC NET	789	134	3,622	10,029	13,191	14,206	20,737	11,421	11,108	5,132	2,436	4,397
TOTAL BC SPORT	2,108	850	23,384	59,647	98,400	156,920	65,226	55,730	10,911	30,546	46,622	23,832
ESCAPEMENT	1,643	1,763	19,825	45,480	69,253	55,862	47,009	43,136	45,154	31,115	20,165	31,434
% SURVIVAL[1]			14.2	9.3	15.0	16.6	13.4	9.1	8.0	5.2	5.8	5.5
% INSIDE[2]	42.7	41.8	72.6	56.7	60.3	79.4	43.6	55.2	3.7	52.0	74.9	19.2

[1] 1985 to 1998 survivals were estimated assuming Inch exploitations (see text). [2] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 9 (continued). Chilliwack Hatchery.

Return Year:	1995	1996	1997	1998
No.Smolts Rel'd:	1,939,584	1,795,181	1,702,085	1,943,961
Fishery:				
NTR	-	-	188	-
NCTR	-	-	-	-
SCTR	319	-	-	-
NWTR	5,782	9,581	-	-
SWTR	29,212	20,298	-	-
GSTR	-	-	-	4
JFTR	-	-	-	-
NN	-	-	-	-
CN	-	-	-	-
NWVN	-	-	-	-
SWVN	-	-	-	-
JSN	-	332	276	4
GSN	-	-	-	-
FGN	457	-	133	4
JFN	1,959	-	164	-
FSN	-	-	-	-
NSPT	-	-	-	-
CSPT	182	-	355	-
ACSP	-	-	-	-
WSPT	542	854	1,274	-
GSPTN	88	1,112	-	-
GSPTS	-	315	-	91
JFSP	321	4,737	3,266	-
FWSP	1,953	3,670	4,388	651
WASHINGTON	5,120	2,695	3,832	323
ALASKA	-	281	-	75
TOTAL BC TROLL	35,312	29,879	188	4
TOTAL BC NET	2,416	332	573	7
TOTAL BC SPORT	3,087	10,686	9,282	741
ESCAPEMENT	27,223	27,404	28,285	14,755
% SURVIVAL[1]	3.0	2.9	1.8	0.8 [3]
% INSIDE[2]	0.2	3.8	0.0	53.3

[1] 1985 to 1998 survivals were estimated assuming type 'B' Inch exploitations (see text). [2] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington. [3] Inch and Chilliwack recoveries include pelvic clipped coho but these recoveries were excluded for the survival calculation.

Table 10. Estimated CWT recoveries by catch region for adult coho from Salmon River (Langley), 1979-1981 and 1987-1998. Escapements, survivals and 'inside' catch distributions are also given for 1987-1998.

Return Year:	1979	1980	1981	1982	1983	1984	1985	1986	1987	1,988	1989	1990
No.Tagged Smolts:	13,473	31,965	30,232						7,891	20,022	24,634	26,911
Fishery:												
NTR	-	4	-						-	-	-	6
NCTR	-	6	3						-	-	-	5
SCTR	5	25	122						7	31	-	31
NWTR	-	43	117						22	94	96	131
SWTR	106	482	638						111	266	563	553
GSTR	275	609	289						205	680	101	563
JFTR	-	-	-						-	-	-	-
NN	-	-	-						-	-	-	-
CN	-	11	-						-	2	-	2
NWVN	-	-	-						-	-	-	-
SWVN	-	3	1						-	5	36	-
JSN	24	50	240						2	61	32	38
GSN	-	3	18						3	5	8	3
FGN	-	140	-						1	108	6	94
JFN	23	100	118						56	33	263	43
FSN	-	-	-						-	5	-	-
NSPT	-	-	-						-	-	-	-
CSPT	-	5	-						12	37	-	7
ACSP	-	-	-						-	-	-	-
WSPT	-	-	-						16	-	26	-
GSPTN	302	919	640						260	1,235	529	789
GSPTS	179	401	283						44	512	301	151
JFSP	4	13	8						26	-	95	36
FWSP	-	-	4						7	8	-	-
WASHINGTON	98	597	340						71	205	366	224
ALASKA	-	-	-						-	-	-	-
TOTAL BC TROLL	386	1,169	1,169						345	1,071	760	1,289
TOTAL BC NET	48	307	377						62	218	344	180
TOTAL BC SPORT	485	1,337	935						365	1,791	951	982
ESCAPEMENT			1						373	1,102	903	801
% SURVIVAL									15.4	21.9	13.5	12.9
% EXPLOITATION[1]									69.3	74.9	72.8	77.0
% MARINE EXPLOIT'N[2]									68.8	74.7	72.8	77.0
% INSIDE[3]	82.3	68.6	48.9						66.6	79.0	45.3	61.3

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 10 (continued). Salmon River (Langley).

Return Year:	1991	1992	1993	1994	1995	1996	1997	1998
No.Tagged Smolts:	20,390	29,435	28,141	15,611	35,256	30,052	22,049	5,676
Fishery:								
NTR	-	-	-	-	-	-	-	-
NCTR	-	-	-	-	-	-	-	-
SCTR	1	71	19	-	5	-	-	-
NWTR	96	318	69	48	142	303	-	-
SWTR	707	317	79	550	746	759	-	-
GSTR	15	398	516	57	-	-	-	-
JFTR	-	-	-	-	-	-	-	-
NN	-	-	-	-	-	-	-	-
CN	-	3	-	-	-	-	2	-
NWVN	-	-	-	-	-	-	-	-
SWVN	-	2	-	-	-	-	-	-
JSN	-	16	10	6	3	7	8	-
GSN	-	3	-	2	-	-	-	-
FGN	24	52	3	19	-	-	-	-
JFN	129	39	8	66	54	2	12	-
FSN	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-
CSPT	-	30	10	-	-	-	-	-
ACSP	-	-	-	-	-	-	-	-
WSPT	26	50	-	28	19	18	6	-
GSPTN	10	456	403	167	-	63	10	-
GSPTS	-	217	149	26	54	55	-	-
JFSP	12	60	8	32	49	114	103	-
FWSP	-	-	-	-	5	-	-	-
WASHINGTON	184	74	18	-	127	66	61	3
ALASKA	-	3	-	-	-	8	-	-
TOTAL BC TROLL	818	1,104	683	655	892	1,062	-	-
TOTAL BC NET	153	114	21	92	57	10	21	-
TOTAL BC SPORT	47	813	570	253	127	251	119	-
ESCAPEMENT	371	730	1,079	495	1,248	982	720	141
% SURVIVAL	7.7	9.6	8.4	9.6	7.0	7.9	4.2	2.5
% EXPLOITATION[1]	76.4	74.3	54.5	66.9	49.1	58.7	21.8	1.7
% MARINE EXPLOIT'	76.4	74.3	54.5	66.9	48.9	58.7	21.8	1.7
% INSIDE[3]	2.4	52.6	83.9	25.0	5.0	8.9	7.4	0.0

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 11. Estimated CWT recoveries by catch region for adult coho from Black Creek, 1979-1980 and 1986-1998. Escapements, survivals and 'inside' catch distributions are also given.

Return Year:	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
No.Smolts Rel'd:	29,426	39,357						24,134	31,648	35,640	74,997	29,203
Fishery:												
NTR	31	13						16	94	36	88	42
NCTR	64	123						23	25	40	15	26
SCTR	416	684						656	363	379	451	348
NWTR	366	602						308	375	519	993	334
SWTR	314	392						161	131	141	561	138
GSTR	461	598						128	467	346	209	303
JFTR	-	-						-	-	-	-	-
NN	-	3						-	9	-	32	-
CN	26	46						15	19	23	32	13
NWVN	-	-						-	-	-	-	-
SWVN	3	17						-	-	-	9	5
JSN	828	1,086						322	275	326	1,166	354
GSN	-	5						6	18	6	32	44
FGN	-	-						-	-	-	6	-
JFN	66	76						29	23	3	223	61
FSN	-	-						-	-	-	-	-
NSPT	-	-						-	-	-	-	-
CSPT	-	22						39	13	59	65	36
ACSP	4	-						-	-	-	-	-
WSPT	-	-						8	12	-	45	6
GSPTN	2,250	2,317						418	1,163	1,248	1,646	877
GSPTS	195	215						19	38	75	202	36
JFSP	4	12						9	6	-	25	22
FWSP	-	-						5	5	-	-	-
WASHINGTON	92	312						28	47	23	191	25
ALASKA	-	4						3	4	10	21	12
TOTAL BC TROLL	1,651	2,413						1,291	1,455	1,460	2,316	1,190
TOTAL BC NET	923	1,232						373	343	358	1,499	477
TOTAL BC SPORT	2,454	2,566						498	1,236	1,382	1,984	977
ESCAPEMENT	475	1,278						824	531	1,279	2,502	944
% SURVIVAL	19.0	19.8						12.5	11.4	12.7	11.4	12.4
% EXPLOITATION[1]	91.5	83.6						72.7	85.3	71.7	70.6	73.9
% MARINE EXPLOIT'N[2]	91.5	83.6						72.5	85.2	71.7	70.6	73.9
% INSIDE[3]	57.8	50.4						26.2	55.0	52.0	35.4	45.8

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 11 (continued). Black Creek.

Return Year:	1991	1992	1993	1994	1995	1996	1997	1998
No.Smolts Rel'd:	118,382	52,351	49,860	54,996	75,970	18,152	13,736	69,996
Fishery:								
NTR	66	69	52	22	73	25	13	-
NCTR	21	79	4	13	13	-	-	-
SCTR	143	896	133	50	18	-	214	-
NWTR	1,831	1,023	182	294	421	92	-	-
SWTR	1,049	209	37	647	636	72	-	-
GSTR	75	345	319	189	-	-	-	-
JFTR	-	-	-	-	-	-	-	-
NN	4	-	9	8	10	-	-	-
CN	21	64	11	18	29	-	1	-
NWVN	-	-	-	-	-	-	-	-
SWVN	5	4	-	5	1	-	-	-
JSN	780	529	304	185	154	9	28	6
GSN	28	23	12	-	-	-	-	-
FGN	10	-	-	-	-	-	-	-
JFN	473	31	-	114	34	-	-	-
FSN	-	-	-	-	-	-	-	-
NSPT	-	-	-	-	-	-	-	-
CSPT	232	311	108	55	67	42	17	-
ACSP	-	-	-	-	-	-	-	-
WSPT	138	99	-	29	68	-	-	-
GSPTN	1,032	1,117	1,192	752	94	77	14	-
GSPTS	14	100	33	38	-	-	-	-
JFSP	44	21	2	81	48	37	47	-
FWSP	-	-	6	-	10	-	-	-
WASHINGTON	412	29	17	8	87	6	27	15
ALASKA	39	60	97	59	204	70	5	73
TOTAL BC TROLL	3,186	2,622	725	1,214	1,161	188	226	-
TOTAL BC NET	1,320	651	337	331	229	9	29	6
TOTAL BC SPORT	1,459	1,647	1,341	954	287	156	78	-
ESCAPEMENT	2,616	1,388	638	584	1,494	182	235	3,085
% SURVIVAL	7.6	12.2	6.3	5.7	4.6	3.4	4.4	4.5
% EXPLOITATION[1]	71.0	78.3	79.8	81.5	56.8	70.2	60.8	3.0
% MARINE EXPLOIT'N[2]	71.0	78.3	79.6	81.5	56.6	70.2	60.8	3.0
% INSIDE[3]	18.7	31.4	61.9	38.3	5.0	18.1	4.2	0.0

[1] FWSP as part of catch. [2] FWSP as part of escapement. [3] Recoveries in the inside troll and sport fisheries as a proportion of total marine recoveries, excluding recoveries from Washington.

Table 12. Time series of adult (age .1) coho escapements to Strait of Georgia/lower Fraser River streams, including Black Creek and Salmon River (Langley). All except Chase River have no juvenile coho enhancement..

Return Year	Black	Chase*	Cowichan Tributaries							Salmon (Langley)	Upper Pitt
			Mesachie	Richards	Rotary Channel	Oliver	Robertson Side Chan.	Patricia	Shaw		
1941			1,291			890					
1942			999			307					
1943			1,826			394					
1944			3,292			258					
1945											
1975	7,989										
1976											
1977			1,697		719		1,575	816			7,500
1978	7,587										17,500
1979											5,000
1980											2,500
1981											4,512
1982											7,297
1983											3,545
1984			1,153								
1985	5,992										
1986	4,818		291				366				
1987	785		431				393			11,947	
1988	3,122	318	170				285			9,152	
1989	3,273	579	156		242	528	475	1,106		8,427	
1990	1,237	1,615	574	1,201	553	811	621	1,320	1,626	4,942	
1991	3,574	1,888	77	393	155	97	199	550	1,161	4,321	
1992	1,722	508	13	124	69	5	30	274	591	2,604	
1993	959	900	41	246	111	313	217	320	573	5,913	
1994	900	1,300	133	446	69	306	57	715	1,588	1,941	6,976
1995	1,760	450	374	372	10	95	83	366	701	4,214	5,053
1996	284	162	26	97	31	5	22	78	365	2,639	5,269
1997	1,200	200	171	476		35		179	322	3,949	9,386
1998	7,616	349	602	746		109		627	302	2,993	8,296

* There have been hatchery smolt releases in Chase River since 1990. See Fig. 9 for estimates of wild and enhanced escapement components.

Table 13. Estimates of escapements of adult coho to Georgia Basin streams in 1998. All except Black, Salmon and Upper Pitt are AUC estimates. Females per kilometre estimates are based on an assumed 50:50 sex ratio and accessible mainstem and major tributary lengths. Data are preliminary.

Area	Stream	Estimated Escapement			Females/km	
		Total	Enhanced[1]	Wild	Total	Wild
13	Bird Cove	50		50	23	23
	White Rock Pass	13		13	2	2
				Median	12	12
14	Black	7,616		7,616	113	113
	Millard	179	37	142	60	47
	Trent	1,406	595	811	70	41
	Tsable	1,068	165	903	80	67
	Cowie	357	139	218	27	16
	Coal	477	218	259	64	35
	Waterloo	107	98	9	15	1
	Nile	227		227	17	17
	Morison	544		544	181	181
	(Englishman R. trib.)			Median	64	41
17	Nanoose	607		607	54	54
	Bonell	144		144	15	15
	Chase	349		349	39	39
	Beck	228		228	42	42
	Walker	43	12	31	11	8
	Bush	176		176	37	37
	Bonsall	525	278	247	33	15
				Median	37	37
18	Kelvin	71		71	6	6
	Richards	746		746	62	62
	Oliver	109		109	18	18
	Mesachie	602		602	301	301
	Patricia	627		627	314	314
	Shaw	302		302	50	50
				Median	56	56
28A	McCartney	34		34	17	17
	Parkside	16		16	16	16
	Thain	47		47	47	47
				Median	17	17
28B	Little Stawamus	179		179	28	28
	Mashiter	60		60	38	38
	Pillchuck	433		433	72	72
				Median	38	38
29B	Nathan	347		347	27	27
	Salmon R.(langley) Sys	2,992		2,992	55	55
				Median	41	41
29C	Donegani	353		353	110	110
	MacIntyre	347		347	96	96
				Median	103	103
29D	Lagace	73		73	6	6
	Whonnock	496		496	34	34
				Median	20	20
29E	Fourteen Mile	469		469	293	293
	Hopedale	116		116	105	105
	Kawkawa	429		429	134	134
	Post	1,121		1,121	224	224
	Street	12		12	7	7
				Median	134	134

[1] Assuming a fry to smolt survival of 15% and the same survival to escapement as Black Creek coho.

Table 14. Percent smolt to adult survivals of four hatchery and three wild coho stocks.

Brood Year	Hatchery Indicator Stocks				Wild Indicator Stocks		
	Quinsam	Big Qualicum	Inch	Chilliwack[1]	Black	Salmon	Mesachie
1973		28.3					
1974	7.2	16.4					
1975	9.7	15.2					
1976	6.5	19.3			19.0 [2]		
1977	9.5	28.7			19.8 [2]		
1978	7.0	12.7					
1979	4.5	10.3					
1980	7.1	11.1					
1981	5.2	7.9					
1982	7.9	5.0	6.8	14.2			
1983	6.9	1.0	6.0	9.3	12.5		
1984	7.9	0.8	8.5	15.0	11.4	15.4	
1985	7.9	1.7	20.3	16.6	12.7	21.9	6.9
1986	10.2	1.3	10.9	13.4	11.4	13.5	4.9
1987	7.8	4.9	8.0	9.1	12.4	12.9	7.0
1988	4.2	6.5	7.1	8.0	7.6	7.7	3.2
1989	5.9	5.8	9.8	5.2	12.2	9.6	2.5
1990	3.5	6.7	8.3	5.8	6.3	8.4	2.0
1991	2.3	6.8	6.0	5.5	5.7	9.6	2.7
1992	2.5	2.9	5.5	3.0	4.6	7.0	
1993	1.4	1.5	3.9	2.9	3.4	7.9	
1994	1.1	1.4	1.0	1.8	4.4	4.2	
1995	1.0	0.3	0.5	0.8	4.5	2.5	

[1] Survival of Chilliwack adults to the marine fisheries divided by marine exploitations of Inch adults.

[2] Probably under-estimates due to under-estimated escapements.

Table 15. Survivals and exploitations of 1995 brood year coho that were pelvic fin clipped compared to those that were not.

	% Survival		% Total Exploitation[1]		% Marine Exploitation[1]	
	Clipped	Not Clipped	Clipped	Not Clipped	Clipped	Not Clipped
Big Qualicum	0.10	0.31	1.25	19.71	1.25	8.97
Chilliwack	0.51	0.88	6.47	9.97	2.38	5.88
Inch	0.47	0.54	21.88	16.89	2.38	9.59
Mean	0.36	0.58	9.87	15.53	2.00	8.14

[1] Total and marine exploitations are exploitations calculated with FWSP included in the catch and in the escapement, respectively. None of the Quinsam Hatchery production was pelvic-clipped.

Table 16. Percent exploitation rates of adults from three hatchery and two wild coho stocks. Marine exploitation rates are more likely to reflect exploitations of wild stocks.

Return	Quinsam		Big Qualicum		Inch		Black		Salmon	
Year	Total[1]	Marine[1]	Total	Marine	Total	Marine	Total	Marine	Total	Marine
1976			91.4	91.4						
1977	83.9	83.9	72.1	72.1						
1978	79.6	79.6	72.2	72.2						
1979	71.1	71.1	72.5	72.5			91.5 [2]	91.5 [2]		
1980	81.5	81.5	78.3	78.3			83.6 [2]	83.6 [2]		
1981	76.2	76.2	69.3	69.3						
1982	72.2	72.2	79.4	79.4						
1983	77.2	77.1	81.0	80.9						
1984	67.2	67.0	68.2	67.9						
1985	76.8	76.4	84.0	83.2	90.7	90.1				
1986	73.3	73.2	74.4	74.4	79.8	79.5	72.7	72.5		
1987	81.8	81.6	73.6	72.0	84.0	83.6	85.3	85.2	69.3	68.8
1988	78.1	77.9	80.2	80.2	88.7	87.9	71.7	71.7	74.9	74.7
1989	70.5	70.5	61.4	61.4	68.0	67.1	70.6	70.6	72.8	72.8
1990	83.3	82.9	69.2	68.6	86.2	86.0	73.9	73.9	77.0	77.0
1991	66.9	66.9	69.2	68.8	80.1	79.5	71.0	71.0	76.4	76.4
1992	79.0	79.0	76.2	75.9	76.1	75.9	78.3	78.3	74.3	74.3
1993	75.7	75.7	74.0	73.6	78.8	78.3	79.8	79.6	54.5	54.5
1994	73.5	73.5	67.7	64.9	82.1	81.3	81.5	81.5	66.9	66.9
1995	60.6	60.6	55.6	54.7	77.3	76.4	56.8	56.6	49.1	48.9
1996	41.0	41.0	59.4	56.9	82.0	78.4	70.2	70.2	58.7	58.7
1997	39.1	39.1	33.7	32.3	35.0	30.7	60.8	60.8	21.8	21.8
1998	2.5	2.5	19.7	9.0	16.9	9.6	3.0	3.0	1.7	1.7

[1]Total Exploitation: FWSP catch was included in the total catch. Marine Exploitation: FWSP catch was included in the escapement. [2] Probably over-estimates due to under-estimations of escapement.

8 FIGURES

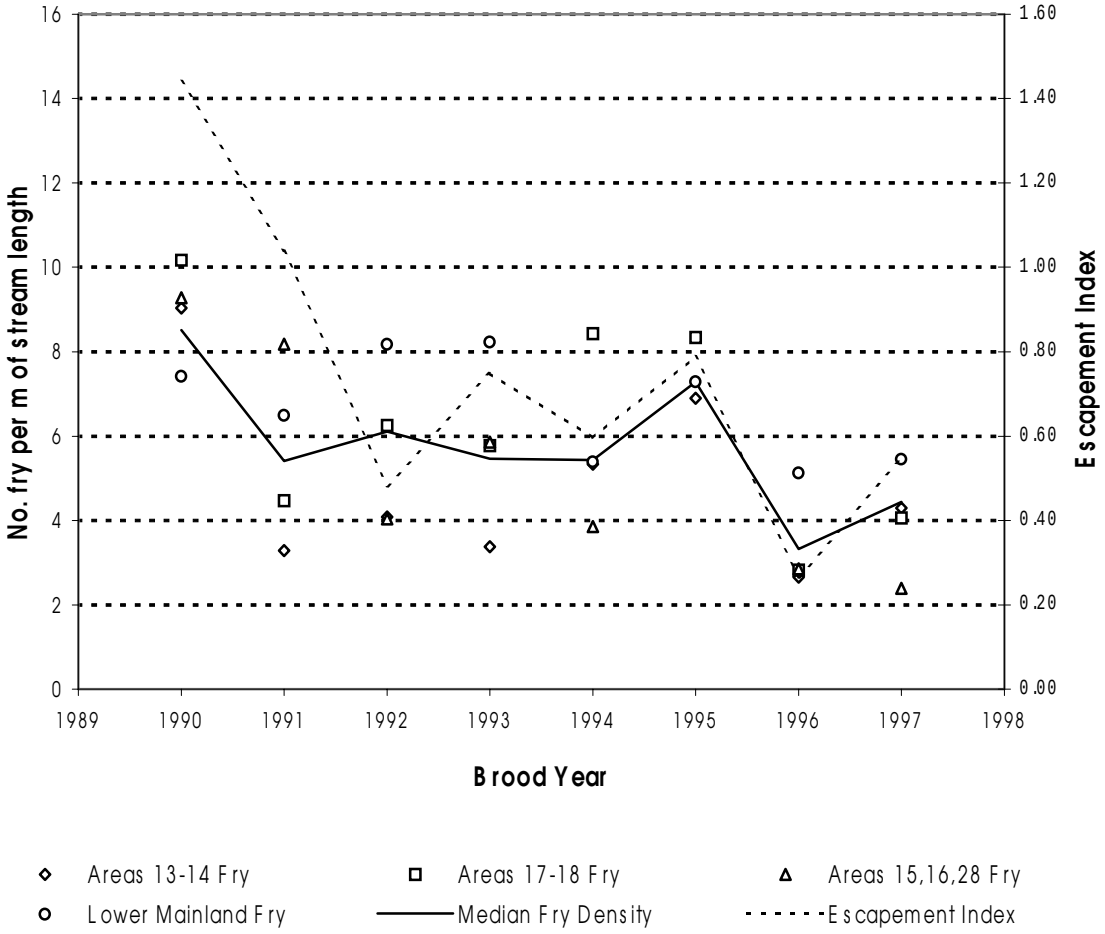

Figure 1. Median densities of coho fry in sub-areas of the Georgia Basin and an index of the parental escapement, 1990 to 1997 brood years. Density data consisted of September abundances of age 0. and age 1. fry per m of reach length in selected streams. Points are median densities for the sub-area and the fry line is a plot of the annual median density in all selected streams in the Basin. Streams with significant enhancement were excluded. The index escapement calculation is described in the text.

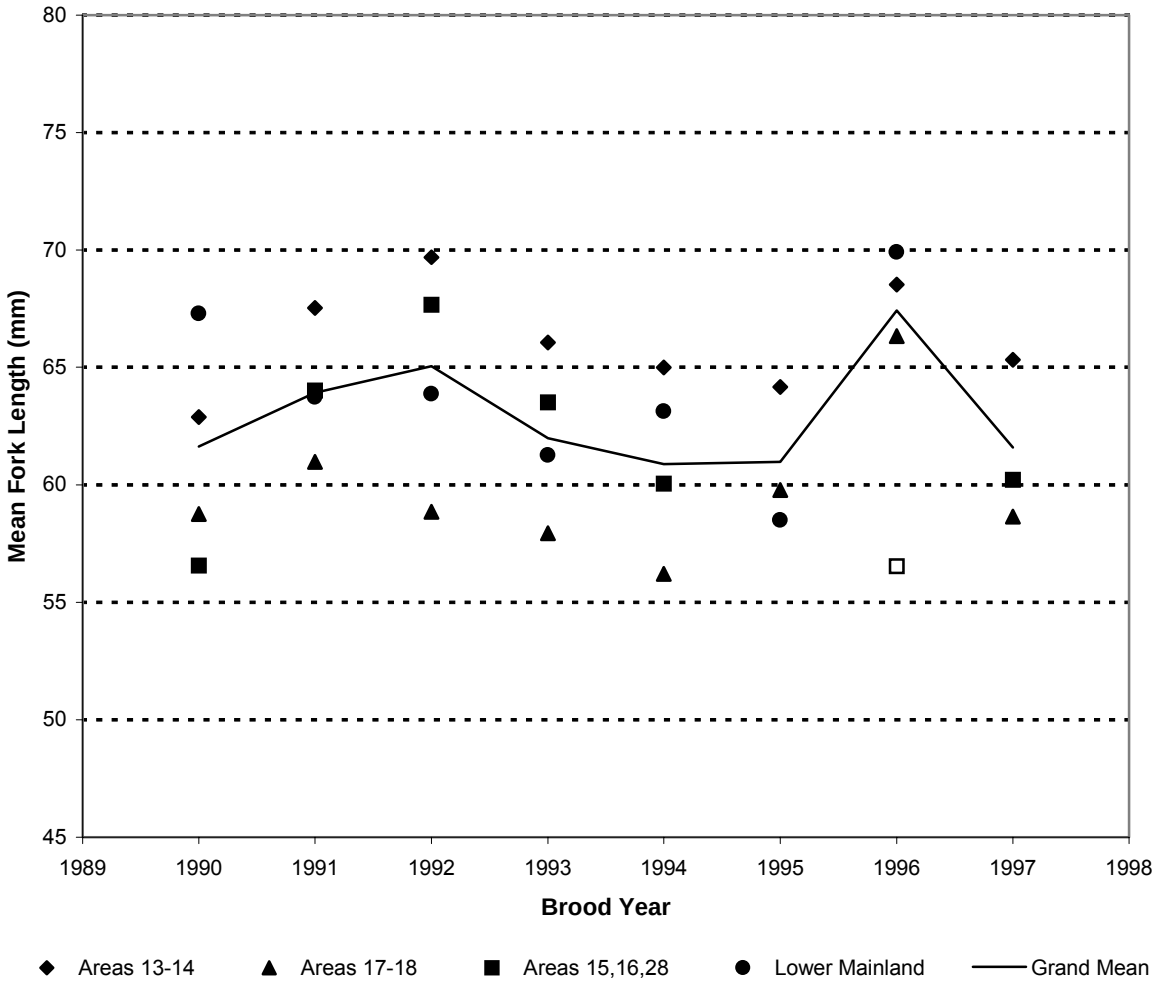

Figure 2. Mean fork length of coho fry in sub-areas of the Georgia Basin, 1990 to 1997 brood years. Points are mean sizes of age 0. fry in selected streams of each sub-area and the line is a plot of the annual mean size in all selected streams in the Basin. Streams with significant enhancement were excluded. The square showing the mean size in the 1996 BY for the Areas 15,16,28 group is open because it is based on only two streams.

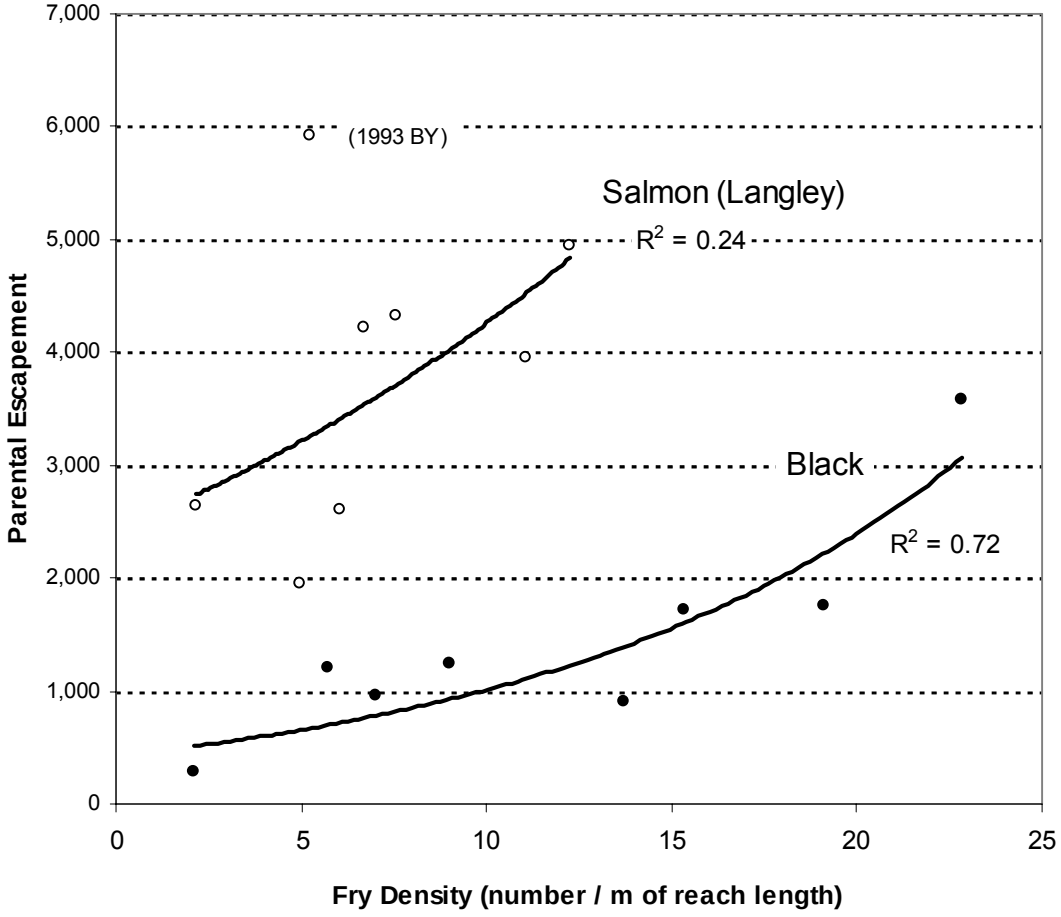

Figure 3. Density of coho fry at one site in Black Creek and one site in Salmon River related to their parental escapements, 1990 to 1997 brood years.

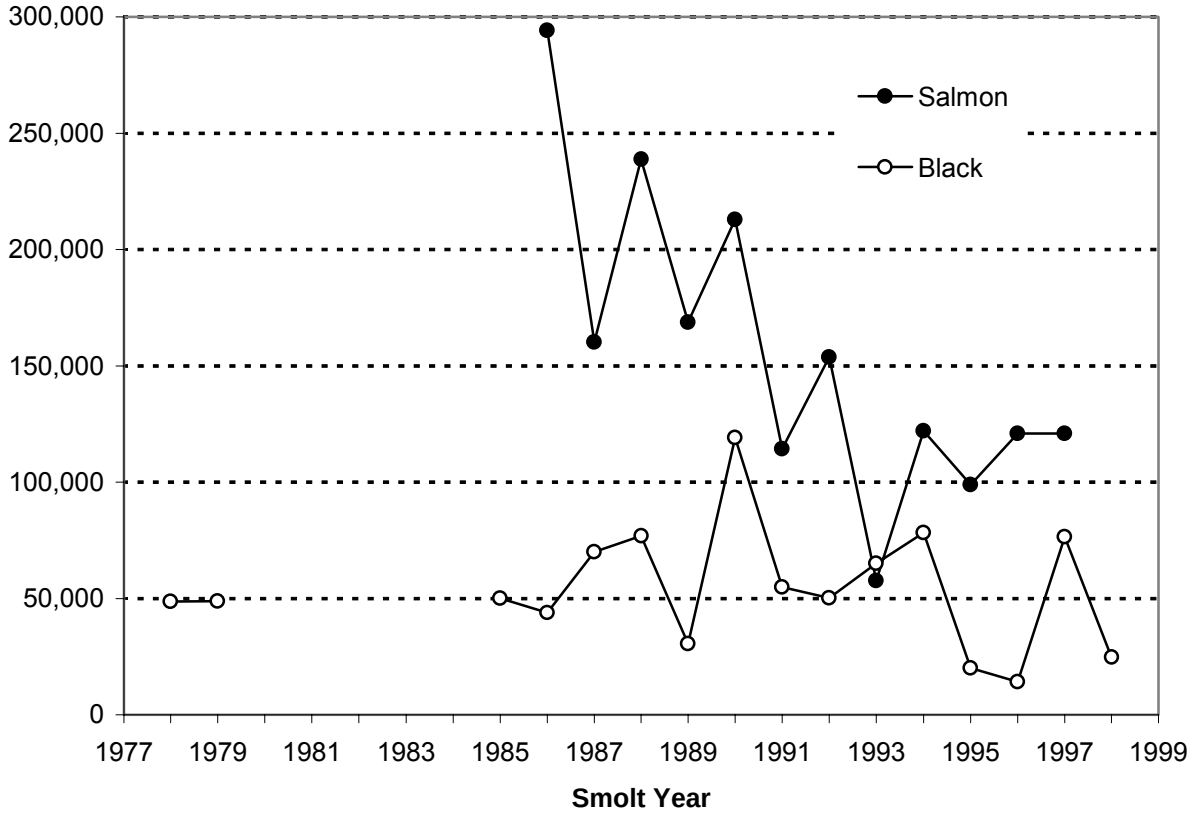

Figure 4. Coho smolt production from Salmon River (Langley) and Black Creek. Black Creek data are fence counts. Salmon River abundances are derived as Petersen MR estimates using the number of adipose fin clipped smolts and the proportion these marked fish represent of the return.

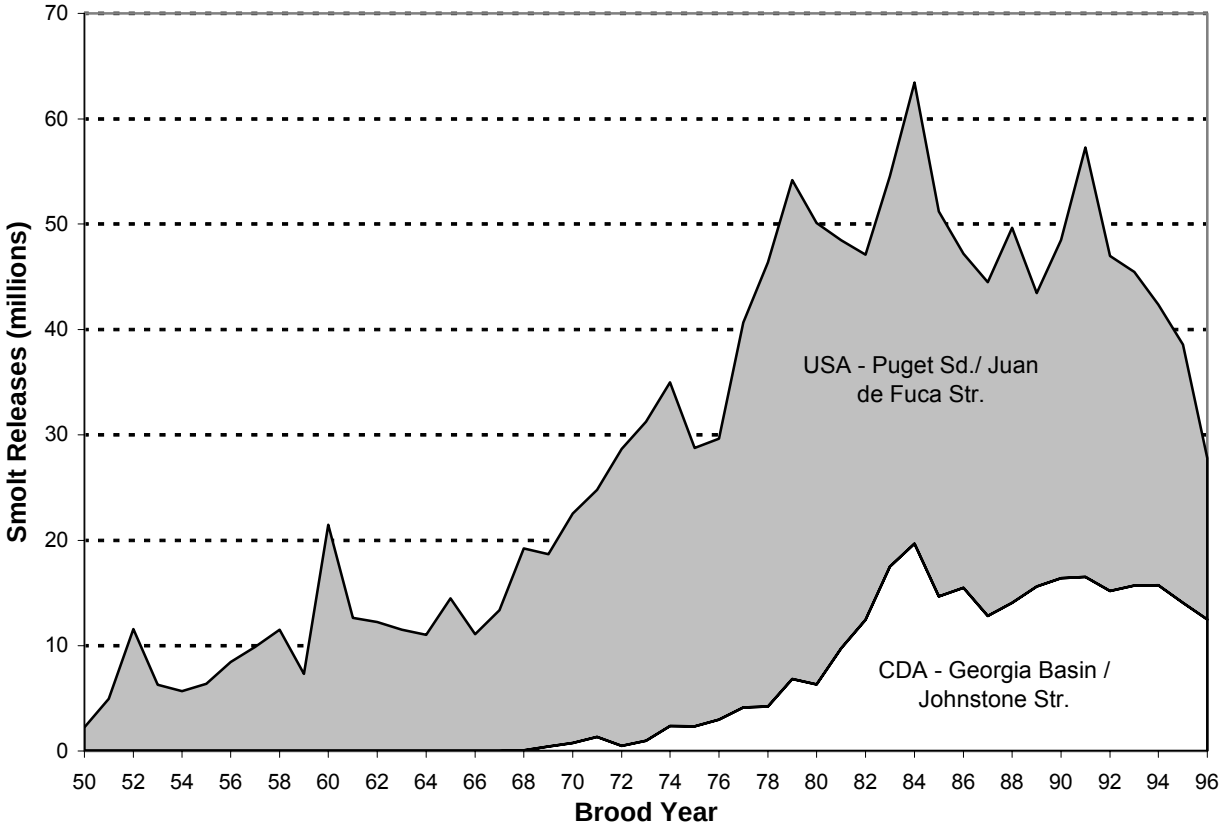

Figure 5. Releases of smolts from Puget Sound / US Juan de Fuca Strait hatcheries and from Johnstone Strait/Georgia Basin hatcheries, 1950 to 1996 brood years.

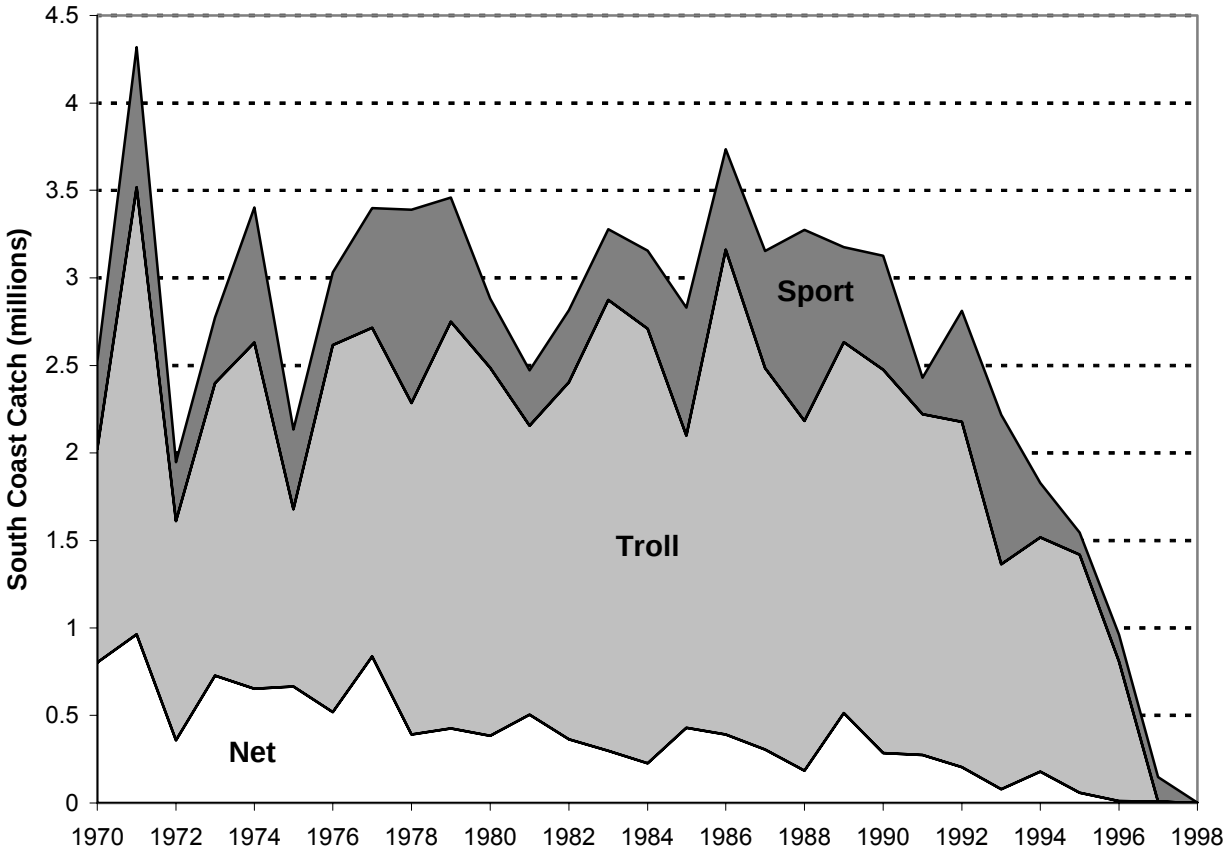

Figure 6. Catch of coho in southern BC by sector, 1970 to 1998.

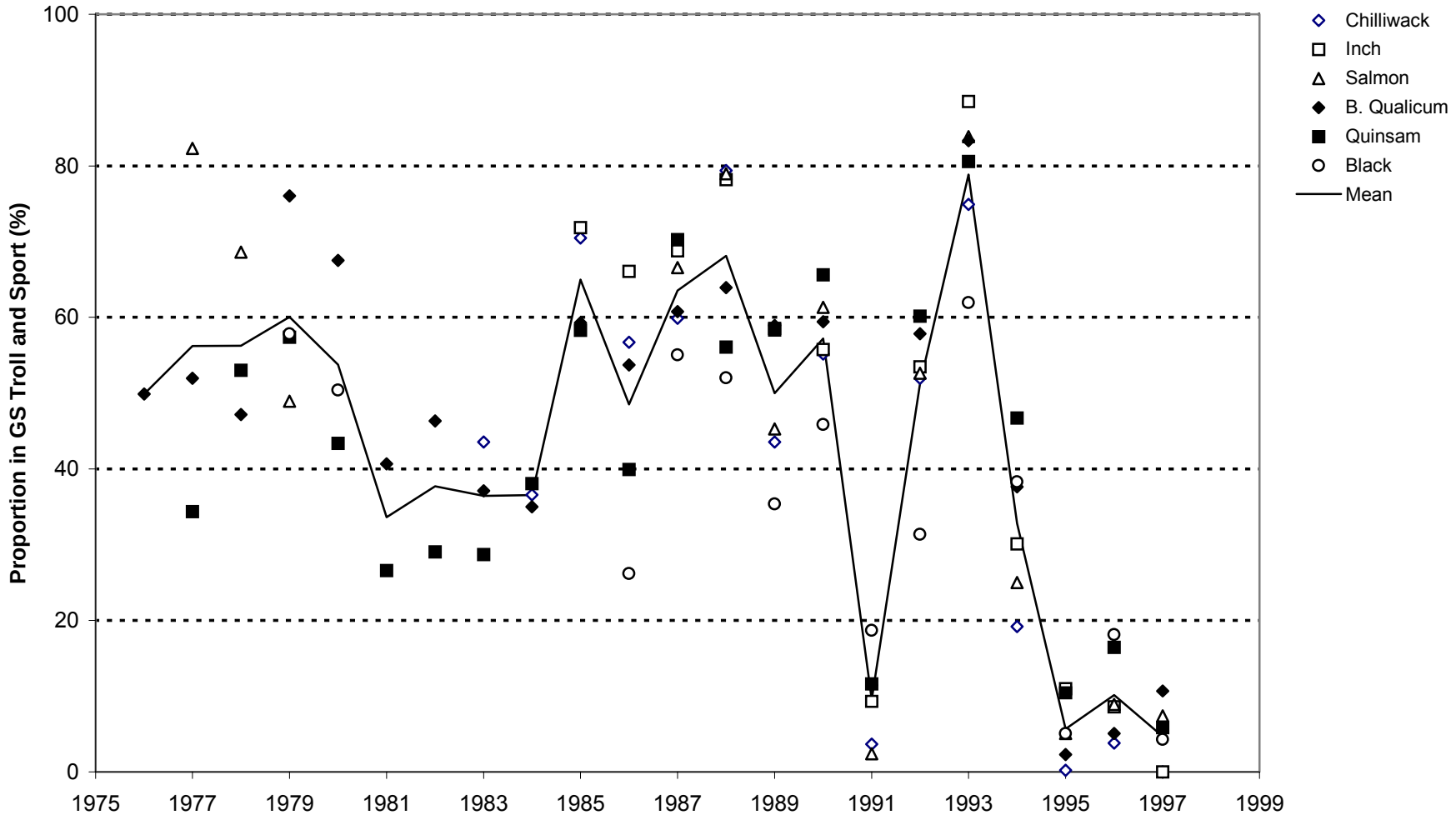

Figure 7. The proportion of the total marine catch of CWT'd coho that were caught in the Strait of Georgia troll and sport fisheries for four hatcheries and Black and Salmon (Langley) wild indicators. Washington State catch estimates are excluded.

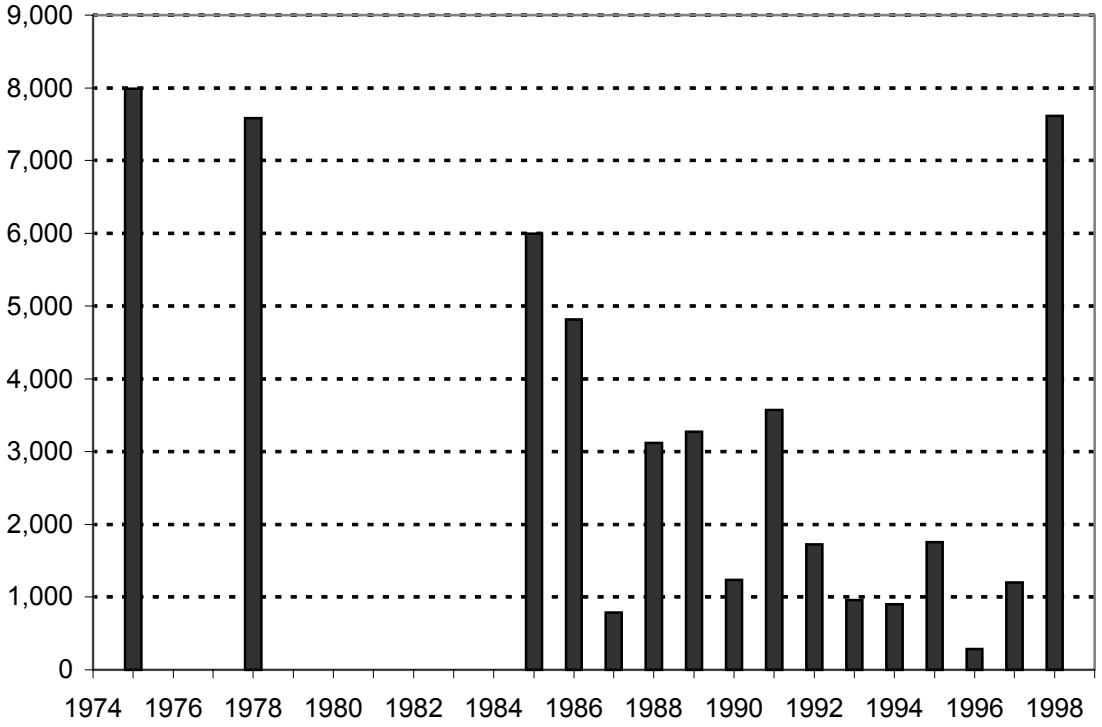

Figure 8. Total escapement estimates of adult coho to Black Creek, 1974 to 1998.

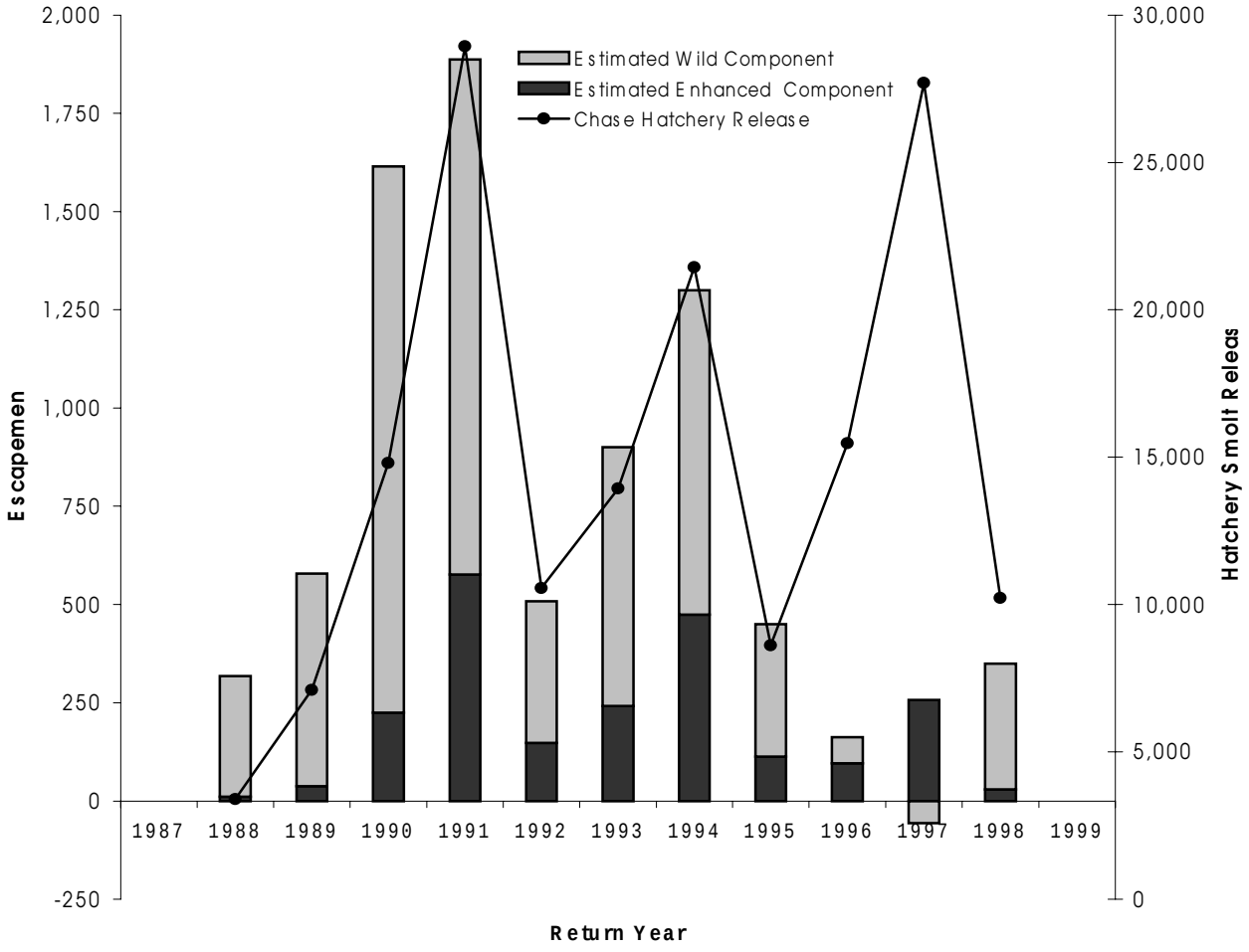

Figure 9. Escapement estimates of adult coho to Chase River in Nanaimo, 1988 to 1998. Smolt releases by the Chase River Hatchery are also shown.

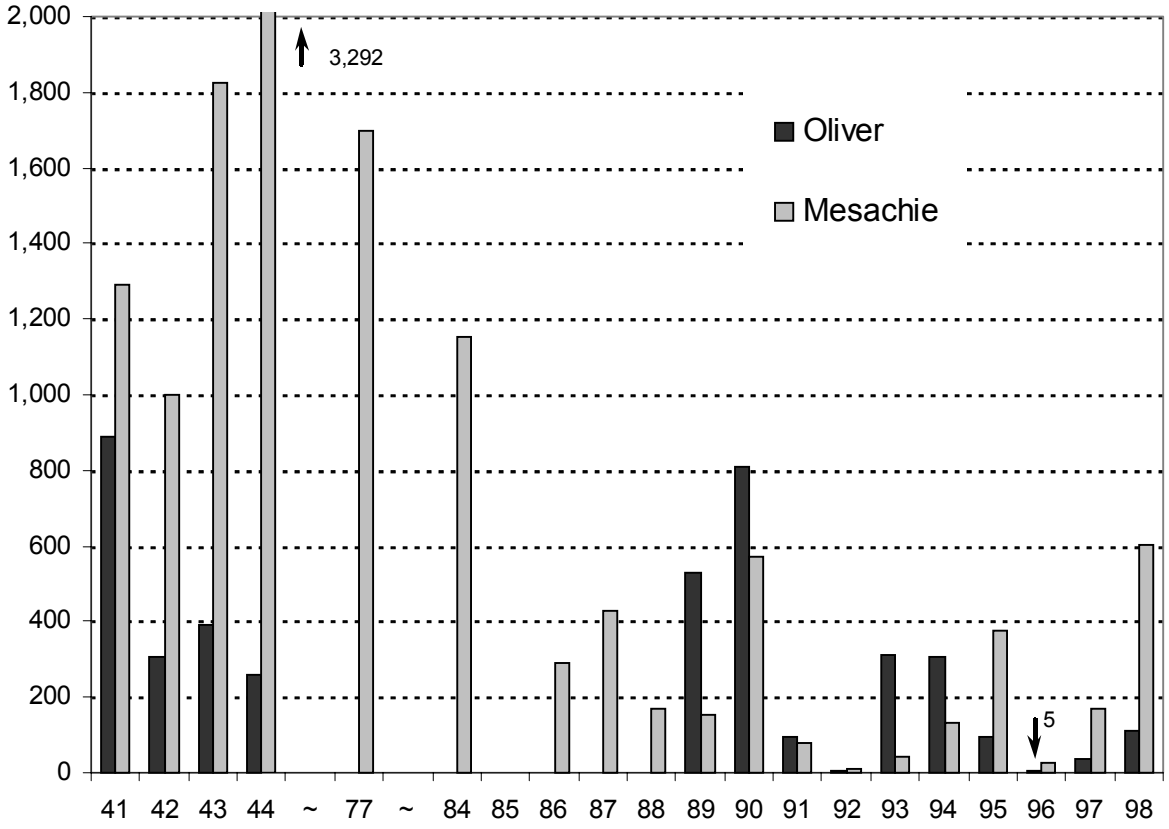

Figure 10. Escapement estimates of adult coho to Oliver and Mesachie creeks in the upper Cowichan River system, 1941 to 1998.

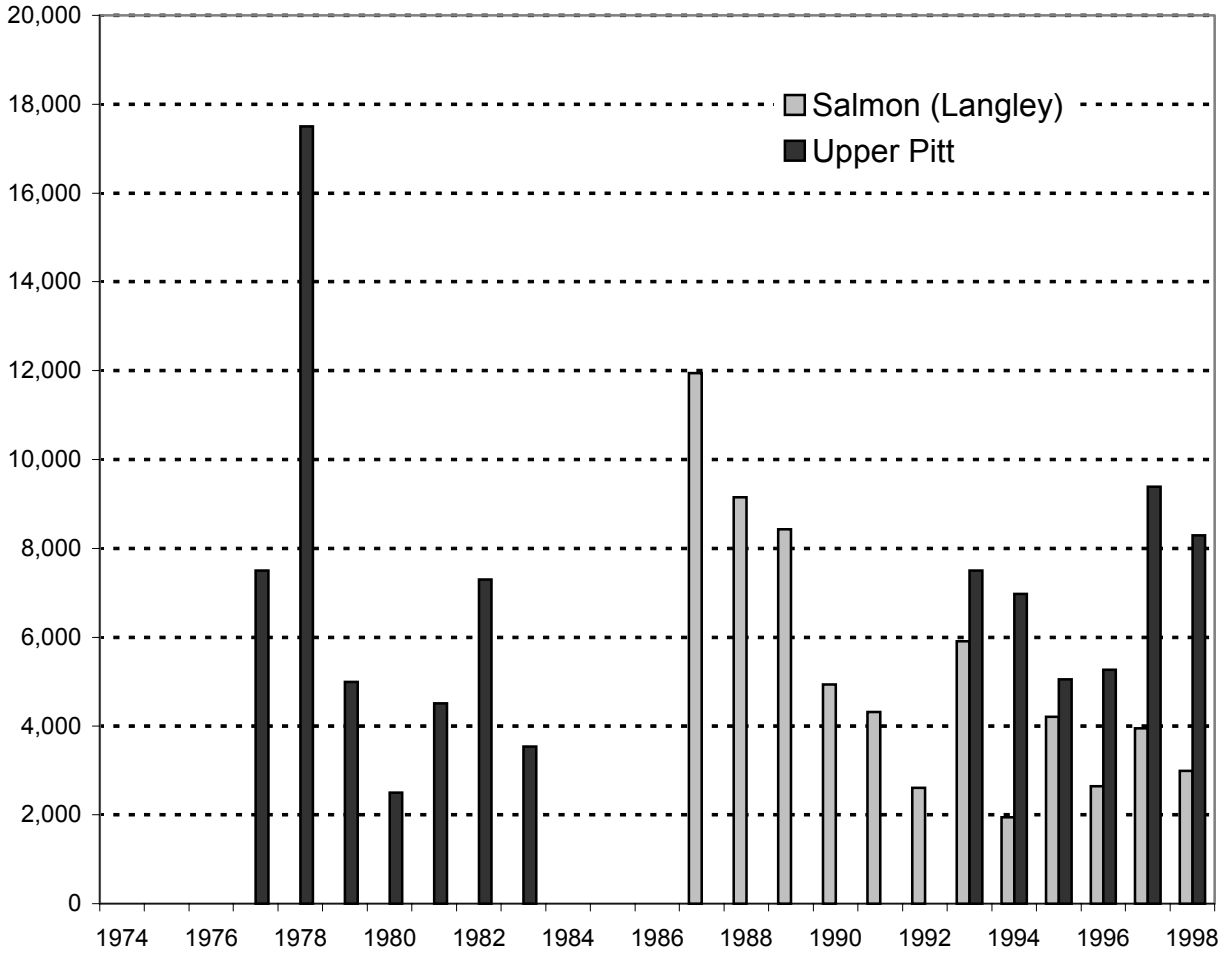

Figure 11. Escapement estimates of adult coho to Salmon River (Langley) and Upper Pitt River, 1977 to 1998.

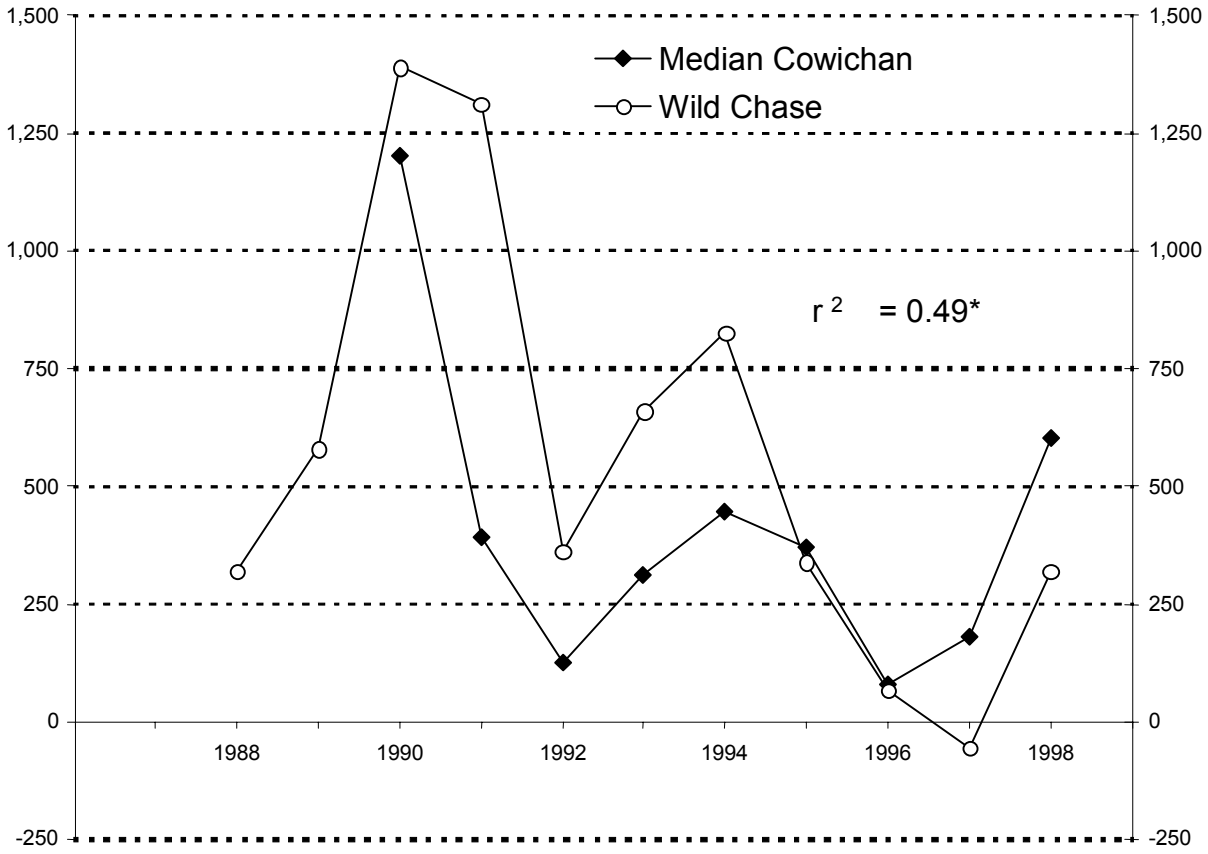

Figure 12. The median adult coho escapement for monitored Cowichan River tributaries, 1990 to 1998, with the 1988 to 1998 Chase River escapements for comparison.

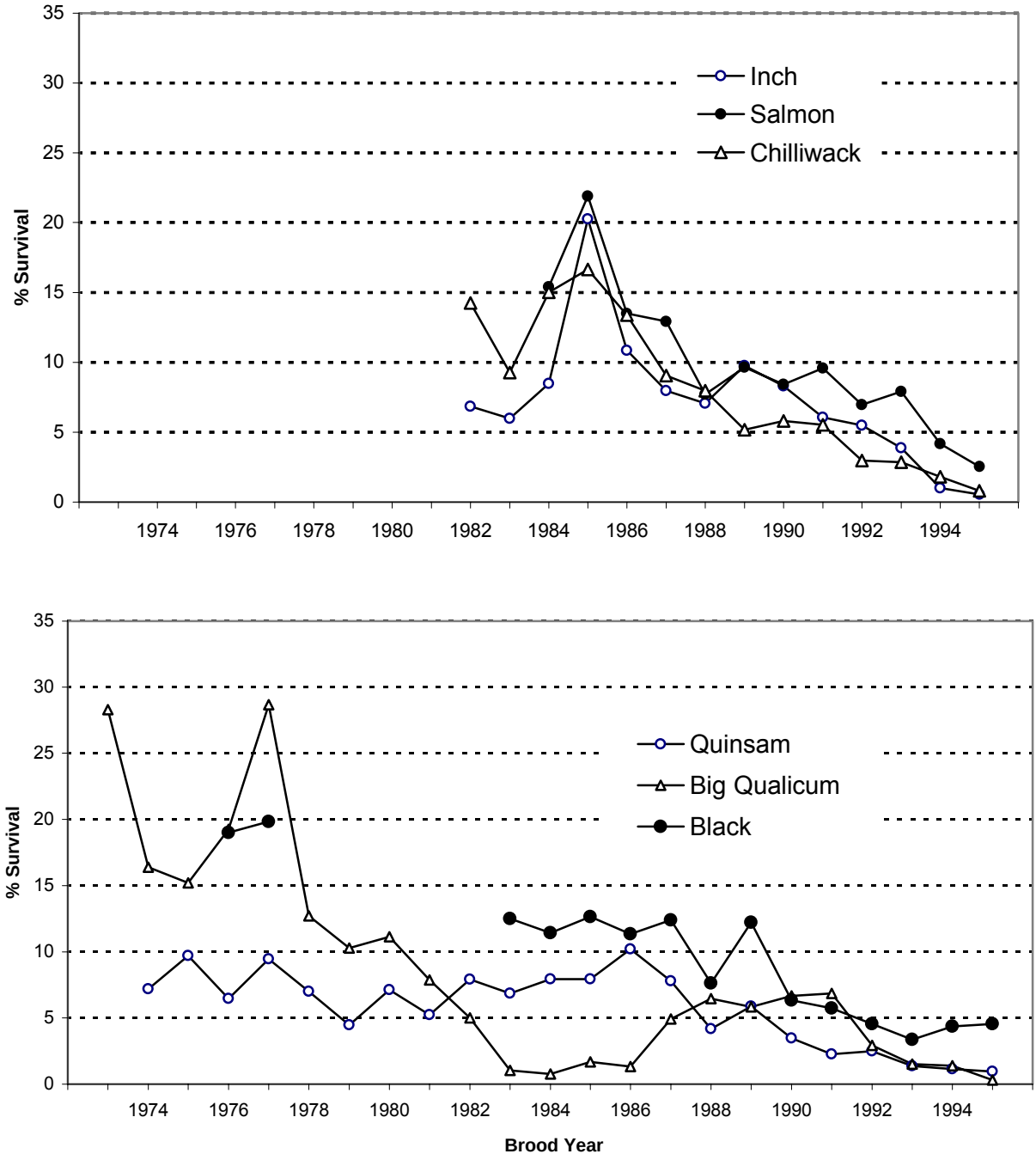

Figure 13. Coho smolt to adult survival of coastal Georgia Basin hatchery and wild indicators, 1973 to 1995 brood years.

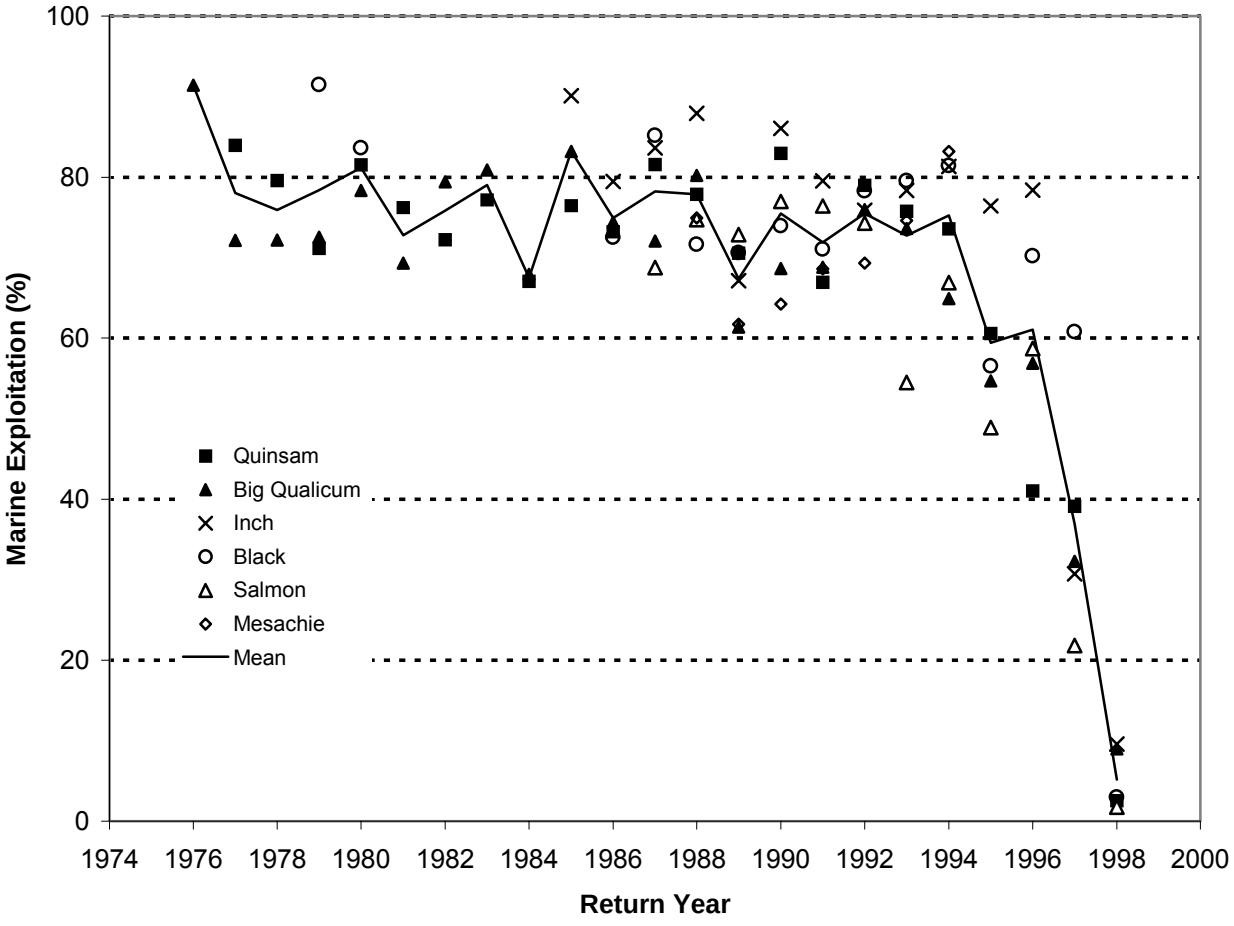

Figure 14. Marine exploitation of coastal Georgia Basin hatchery and wild coho stocks, 1976 to 1998 return years. Freshwater sport catches were treated as part of the escapement.