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Status in 2000 of Coho Stocks Adjacent to the Strait of Georgia

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ABSTRACT

Escapements in 2000 remained poor relative to 10 year averages in all areas of the Georgia Basin except in the lower Fraser system. In terms of the provisional limit reference point of three females/km, virtually all enumerated stocks in the Basin were probably above the limit. Escapements were the result of poor escapements in 1997 and poor marine survival. Most indicator stocks did not improve on their 1997 escapements. Extremely low marine survival is the driving short-term cause of poor abundances. Survival of populations on south-east Vancouver Island is a particular concern. However, the decline has stabilised, with survivals of virtually all indicator stocks in the Basin improving at least slightly. Largely as a result of Selective Mark Fisheries, exploitation of hatchery stocks about doubled to 24% in 2000. Exploitations of wild coho probably also increased with the increased fishing effort, but the level is uncertain and will vary with ocean distribution.

Smolt runs were probably above average in 2000 on Vancouver Island but remained poor on the Sunshine Coast (Areas 15 and 16). The number of smolts was not exceptional at Salmon River in the lower Fraser Valley but fry densities and sizes in 1999 suggest smolt abundances elsewhere in the area may have shown a greater improvement. Smolt runs may have been comparable to 1997, the previous smolt run in this brood line. In a previous Pacific Scientific Advice Review Committee (PSARC) Working Paper, marine survivals and abundances were forecast to remain about the same as in 2000. Forecasts were based on time series projections but the probability of increased ocean recruitment means the forecast abundance (which we are not revising) is more likely to be an under-estimate than an over-estimate. Assuming continued low exploitation of wild stocks, most monitored populations will probably exceed the provisional limit reference point of three females per kilometre of stream, as they have in 1998 and 1999. Considering the current low productivity of Georgia Basin coho, we recommend that fishing mortality remain similar to existing minimal levels in order to ensure that there is a sufficient proportion of escapements that exceed the provisional limit reference point.

The abundance of smolts this spring will probably be below the 10 year average. We expect smolt numbers to remain especially poor on the Sunshine Coast. Throughout all monitored areas of the Basin, fry densities were below average in 2000. This probably resulted from low escapements in 1999. Fry were small, despite lower densities, suggesting over-winter survival may have suffered. However, this winter has been unusually dry and it is not clear what the effect on survival has been.

Two areas of particular concern with respect to their status are the Sunshine Coast (Area 15 and 16) and Southeast Vancouver Island (Areas 18 and 19).

We recommend in the paper that Regional rules or guidelines for the collection and analysis of escapement data are required, especially if stock assessment frameworks use Limit Reference Points of spawner abundance. The likelihood of obtaining reasonably accurate absolute, as opposed to index, measures of escapement needs to be carefully considered. We also recommended that the lower Fraser area requires another full indicator facility or, failing that, more smolt enumerations coupled with fry and adult estimates.

RÉSUMÉ

En 2000, les échappées dans les régions du bassin de Géorgie autres que celles du bas Fraser sont restées faibles par rapport aux moyennes décennales. Presque tous les stocks dénombrés dans le bassin se situaient sans doute au-dessus du point de référence limite provisoire de 3 femelles/km. Les niveaux d'échappée sont attribuables aux échappées faibles en 1997 et au faible taux de survie en mer. Les échappées de la plupart des stocks indicateurs ne se sont pas améliorées par rapport à celles de 1997. Les taux de survie en mer extrêmement faibles sont à l'origine, à court terme, des effectifs peu élevés. La survie des populations du sud-est de l'île de Vancouver est particulièrement préoccupante. Le déclin est toutefois terminé, les taux de survie de presque tous les stocks indicateurs du bassin de Géorgie ayant augmenté au moins légèrement. L'exploitation des stocks de cohos d'élevage a presque doublé pour atteindre 24 % en 2000, cette hausse étant en grande partie attribuable à la pêche sélective de poissons marqués. Étant donné l'effort de pêche accru, l'exploitation de cohos sauvages a sans doute aussi augmenté, mais à un niveau incertain qui variera selon leur répartition en mer.

En 2000, les avalaisons de smolts sur l'île de Vancouver dépassaient sans doute la moyenne, mais elles sont demeurées faibles sur la Sunshine Coast (secteurs 15 et 16). Dans la rivière Salmon (vallée du bas Fraser), le nombre de smolts n'était pas exceptionnel, mais les densités et les tailles des alevins en 1999 portent à croire que l'abondance des smolts ailleurs dans la région a augmenté davantage. Les avalaisons de smolts étaient peut-être comparables à celle de 1997, l'avalaison précédente de cette lignée. Selon un document de travail du Comité d'examen des évaluations scientifiques du Pacifique (CEESP), on prévoyait que les effectifs et les taux de survie en mer resteraient les mêmes qu'en 2000. Les prévisions étaient fondées sur des séries chronologiques, mais la probabilité d'une hausse du recrutement en mer signifie que l'abondance prévue (que nous ne révisons pas) serait une sous-estimation plutôt qu'une surestimation. Si l'on suppose que les stocks sauvages continuent d'être faiblement exploités, la plupart des populations surveillées dépasseront sans doute le point de référence limite provisoire de trois femelles par kilomètre de cours d'eau, comme en 1998 et en 1999. Compte tenu de la faible productivité actuelle du coho du bassin de Géorgie, nous recommandons que la mortalité par la pêche soit maintenue aux taux minimums actuels afin d'assurer qu'une proportion suffisante des échappées dépasse le point de référence limite provisoire.

Ce printemps, l'abondance de smolts sera probablement inférieure à la moyenne décennale. Nous prévoyons que les nombres de smolts resteront particulièrement bas sur la Sunshine Coast. Dans tous les secteurs surveillés du bassin, la densité des alevins en 2000 était inférieure à la moyenne, sans doute en raison des faibles échappées de 1999. Malgré leurs densités réduites, les alevins étaient petits, ce qui laisse croire que leur survie hivernale était faible. Toutefois, l'hiver a été exceptionnellement sec, et on ignore quel effet que cela aurait pu avoir sur le taux de survie.

La Sunshine Coast (secteurs 15 et 16) et le sud-est de l'île de Vancouver (secteurs 18 et 19) sont deux régions où l'état des stocks de cohos est particulièrement préoccupant.

Nous recommandons l'établissement de règles ou lignes directrices régionales pour la collecte et l'analyse de données d'échappée, surtout si des points de référence limites de l'abondance des géniteurs sont utilisés dans les cadres d'évaluation des stocks. Il faut étudier de près la probabilité d'obtenir des mesures d'échappée absolues (plutôt que des indices) dont l'exactitude est raisonnable. Nous recommandons également l'établissement d'une autre installation indicatrice complète dans la région du bas Fraser, ou à défaut de cela, davantage de dénombrements des smolts jumellés à des estimations de l'abondance des alevins et des adultes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This is the eighth Pacific Scientific Advice Review Committee (PSARC) Research Paper presenting an assessment of the coho salmon (*Oncorhynchus kisutch*) populations in the Georgia Basin and provides 2000 data to update the last report (Simpson et al. 2000). The assessment information includes juvenile abundance data, catches, escapements, survival rates and exploitation rates. 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. We do not discuss coho stocks in the Thompson and upper Fraser drainages. An accompanying paper will present a status evaluation for those stocks (Irvine et al. 2001). Forecasts of the 2001 marine survival, abundance and distribution of southern BC coho have already been submitted (Simpson et al. 2001). The 1999 status of west Vancouver Island coho was analysed by Dobson et al. (2000).

1. 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 prohibitively 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 estimating more escapements using 'area-under-the-curve' (AUC) analyses of counts from multiple visits. The stocks discussed in Sections 0 and 0 are the nodes of our network of heightened accuracy data: what we refer to as 'indicator' stocks. The more numerous sources of data where sampling error is expected to be larger make up the 'extensive' network. This largely consists of escapement and fry data.

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. A new wild indicator stock was added in 2000 at Myrtle Creek, near Powell River. Smolts and adults were counted in 2000 and the first coded wire tagged return of adults will be in 2002. 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 having what we characterise as 'intensive' data sets are hatchery stocks or enhanced streams, e.g. Chase River in Nanaimo.

1.1 WILD INDICATOR STOCKS

1.1.1 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 since 1985 have been estimated using mark recapture (MR) analyses of coho tagged at the fence. 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, 1995 and 1999. 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). The 2000 MR estimate was 1,114 adults and the fence count was 775 but an exceptionally good tag recovery resulted in a small confidence interval on the Bayes estimate (95% CI: 948-1336).

We have fence counts of smolts in 1978 and 1979 and for every year since 1985. The fences caught virtually all spring smolts during their operation in most years. The average ratio of estimated to counted smolts is less than 1.03. Estimated numbers are used in this report. The tag rate of returning adults in 1985 was about half the expected rate. Labelle (1990b) thought the most likely explanation was that the actual number of smolts in 1984 was about double the original estimate, i.e. the number of uncounted and untagged smolts was underestimated. However, the proportion of tagged adults was also low in 1997, 1998 and 2000: 24.8%, 40.5% and 50%. Although the adult run in 1997 was small enough that it is conceivable that the untagged adults were missed as smolts, there were fully 4,531 untagged adults estimated in 1998 – too many to be explained this way.

One possible reason is that significant straying may occur into Black Creek, perhaps from Oyster River, which enters the Strait 2.3 km away. Partly to check this, 30,261 and 57,840 adipose-clipped coho smolts were released from the Oyster River Hatchery in 1999 and 2000. If they survived to escapement at the same rate as Quinsam Hatchery coho, the marked escapement in 2000 would have been 385 adults. If the jack: smolt ratio was the same for the two hatcheries there would have been 257 jacks back in 2000. Only one marked jack was found in Black Creek in 2000. It had a CWT, confirming it was part of the Oyster release.

Another hypothesis that has not been tested is that a variable, and at times, large proportion of the juvenile production from Black Creek enters the ocean before the spring. No age 0. coho were captured in a fyke net operated off the adult fence during its operation from October 13 to December 10, 2000.

For now, we will present smolt numbers not corrected for adult mark rate. This uncertainty does not affect estimates of marine survival and exploitation of spring smolts, which are virtually all tagged, since only tagged escapements are used in the calculations. Whether the estimates reflect the survival and exploitation of the entire population is not clear at this time. Low tag rates in escapements are common in other wild indicators, e.g. Lachmach (Lane et al. 1994).

Black Creek smolt and adult assessments up to the spring of 1995 are published: Clark 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).

1.1.2 Cowichan River System

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 km^2. Its mean annual discharge is about 44 m^3/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 estimates 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).

AUC estimates of coho escapements have been made in six or seven tributaries of Cowichan River and Lake 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, respectively. All are wild to the extent that no fry or smolt releases occur, although some fry salvaging has taken place in the past. The spawning habitat in Robertson and Rotary side channels has deteriorated so much we no longer count coho there.

1.1.3 Salmon River (Langley)

Salmon River is a lowland tributary that flows north-east 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. 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 Chapman version of the Petersen MR technique. From 1987 to 1996, coho adults were captured using an electroshocker and marked with disk tags and opercular punches. Starting and continuing since 1997, 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. We estimate escapements by recovering and examining carcasses for marked and unmarked coho (e.g. Schubert et al. 1994a). A complete fence count was achieved in 2000, obviating the need for the MR results except as a calibration on the accuracy of the MR procedure.

Smolt traps were operated in the Salmon River and in Coghlan Creek during the springs of 1978-1980 (Schubert 1982a) and 1986-1999 (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 and 1999 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. The last smolt group to be adipose fin clipped was in 1997. Since then, the coded wire tag has been used for the MR. The subsequent 1999 and 2000 recoveries of tagged adults were not adjusted for long term tag loss. Perhaps of more concern is the possibility that the proportion of tagged adults differs from the proportion of the brood year smolt population that was tagged, as seen in recent years at Black Creek (Sect. 0) and elsewhere (e.g. Lachmach River, Lane et al. 1994). This mark recapture might then be an estimate of all juvenile emigrants, not just the smolts leaving in the April to June period, if that is the reason for the discrepancy, or may be erroneous if the cause is adult straying, for example. Whatever the cause, the effect would be to over-estimate the April to June smolt migration.

1.1.4 Upper Pitt River

The upper Pitt River originates in Garibaldi Provincial Park 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 Port 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 hydrography 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 a reach 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 (Schubert 1982b). Coho spawning is generally confined to side channels and the lower two km of tributaries. A second group of coho may arrive in the river in late January and spawn in early February.

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 2000, escapement has been estimated using the Chapman version of 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.

1.1.5 Myrtle Creek

Myrtle and Whittall creeks in Area 15 were selected in March, 2000, because they had feasible fence sites and supported essentially unenhanced coho populations. Using temporary smolt fences in the following months, 685 smolts were counted at Whittall Creek and 2,130 smolts at Myrtle Creek. Myrtle Creek was selected as the most appropriate stream for the permanent fence for this reason and for logistical reasons.

Myrtle Creek is on the south side of the municipality of Powell River and flows into Malaspina Strait. The creek is accessible to salmon for 7.1 km and has a catchment area of 21.3 km^2. For the first 1.1 km the creek has a moderate gradient of 3.7%, however there are no barriers to fish migration. Beyond this lower section the creek flows through a broad valley with a low gradient averaging 1.1%. This section appears to offer excellent rearing conditions for coho. The stream channel is about 4 m wide in the lower steep gradient section, but narrows to 2 m for much of the upper section. Myrtle Creek is primarily a spring-fed system although outflow from Hammil Lake (area 0.8 km^2) does enter the creek at km 3.8 via a small unnamed tributary. This tributary is currently blocked to fish passage close to its confluence with Myrtle Creek. Land use in this watershed is a mix of rural-residential, agriculture and forestry. There is some urban encroachment around Powell River airport at km 5.6 and some logging operations are active in the headwaters. Cutthroat trout (*O. clarki*) and rainbow trout (*O. gairdneri*) are in the creek and chum salmon (*O. keta*) spawn throughout the first kilometre.

A permanent counting fence facility was constructed between the smolt and adult seasons in 2000. It consists of a concrete pad 11.0 m long, placed in the stream bed between rock filled bulkheads built into each bank. A solid cedar deck was built on top of the concrete foundation. The aluminium fence components are anchored to the pad and bulkheads. The completed structure is designed to withstand high water events with no serious stream bed or bank erosion.

The removable fence components are based on designs being used at Black Creek and Carnation Creek on Vancouver Island (Lill and Sookachoff, 1974). Six "A" frames made from channel and angle aluminium are spaced at 1.1 m intervals, with the bases bolted to the cedar deck and the tops attached to a catwalk grate. The completed fence stands 1.2 m high. Panels are slid in between the channel A frames to seal the fence. Screen panels with 6 mm mesh are used for smolts and grates are used to capture adults. The opening between slats in the grates is 19mm, which prevents jack coho from escaping through the fence. In both configurations, the fish are directed by the fence into trap boxes.

1.2 HATCHERY AND ENHANCED INDICATOR STOCKS

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.

The following hatcheries are used because they have complete escapement information. Data from hatcheries with absent or incomplete escapement data can only be used for catch distribution. This will be the first assessment that uses data from Goldstream Hatchery.

1.2.1 Vancouver Island

Big Qualicum. 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 since the 1969 brood have been consistently marked with adipose clips and 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. Since then, smolts have been mass marked with an adipose clip. Tagging levels have doubled since the 1995 brood. 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 onward, 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 selective fisheries. Since 1999, the terminal marine area was mark retention only while the in-river fishery was open for both marked and unmarked coho between the beginning of October and mid-November. The fishery began in an area north of Big Qualicum River as a mainly shore-based fishery and expanded into the river in mid-October. A single observer patrolled the various access points along the beach daily throughout the fishery and interviewed fishers for catch and effort information. Once the river fishery opened, interview effort was split between the river access at Big Qualicum Hatchery and the beach accesses.

Electronic detection equipment was installed in 1999 to permit detection of coded-wire tags in the escapement.

Goldstream. With more accurate estimates of escapement now possible, the Howard English Hatchery on Goldstream River has been added as a hatchery indicator of survival, distribution and exploitation rate trends for southern Vancouver Island coho stocks. The Goldstream River is approximately 12 km long running south-east from Buchart, Lubbe and Goldstream lakes and north into the head of Saanich Inlet on the south-east coast of Vancouver Island, 25 km west of Victoria. The system is controlled by the Capital Regional District Water Board, which operates a series of reservoirs in the system. Its lower 4 km flows through Goldstream Provincial Park. A barrier falls is located just downstream (inside) of the Park boundary. The Howard English Hatchery is located 5 km from the mouth immediately below Japan Gulch Reservoir. The project consists of incubation and rearing facilities for chinook, chum and coho and a counting fence located 2.5 km from the river mouth. Less than 5% of the returns are estimated to spawn below the fence.

Goldstream has released small numbers of coho since the 1978 brood. Smolt releases were begun with the 1990 brood. All smolt releases except the 1995 brood had a group coded wire tagged. Beginning with the 1996 brood, double index tagging has been carried out (releases of groups of tagged fish with and without the adipose fin removed). In both the 1997 and 1998 broods, 30k were tagged and marked with an adipose clip (Ad-CWT) and 30k 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 of selective mass marked fisheries. Unlike some other Strait of Georgia hatchery coho stocks, adipose fins were not removed from untagged fish at Goldstream.

A fence was installed in 1996 but was not satisfactory and was replaced in 1998. Returning adults are enumerated and sampled for tags and marks at the counting fence and in a subsequent dead pitch. Starting in 1999, coloured Floy tags were placed on adults and jacks passed above the fence with a different colour used each week. This facilitates a mark-recovery population estimate, which is necessary in order to account for fish to passing through the fence uncounted during freshets. Jacks are assessed as for adults except that the fence panel design allows some passage of jacks. We started the survival and exploitation time series in 2000. Prior to 2000, dead pitch surveys were not conducted with sufficient frequency to generate a mark-recovery estimate of escapement.

<u>Quinsam.</u> 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 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 consistently included groups marked with adipose clips and coded-wire tags since the 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 smolts from brood years 1972 to 1976, 1984 and 1985 were also marked. 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. From 1996 brood onward, smolts have been mass marked with an adipose clip. As for Big Qualicum, representative groups of Ad-CWT and CWT-only coho were released. Electronic detection equipment was installed in 1999 to permit detection of coded-wire tags in the escapement.

In 1998, 1999 and 2000 and in some years previously, the diversion fence was topped during high water events. Concerns were raised that some coho that were released above the fence may have dropped back below the fence and returned to the hatchery. These fish were released around a bend just upstream of the fence and it was felt that during periods of high flow, the fish were being carried downstream below the fence before they could recover and orient themselves. Repeat captures will cause an overestimate of the number of coho examined for tags and, since most coded wire tagged coho were not released above the fence, this will cause an under-estimate of the tag rate, the tagged escapement and survival (and an over-estimate of exploitation). For brood 2000, all fish released above the fence received an opercular punch to estimate the rate of movement back downstream and back to the hatchery. In addition, a road extension beyond the fence site allowed releases for the latter part of the run to be made some distance further upstream. An estimated 16.5% (95% CI: 14.1% – 18.9%) of coho in 2000 were repeat captures (pers. comm., G. Bonnell, Oceans and Community Stewardship, South Coast Area). This correction has not been made to the 2000 MRP data but will be incorporated in later Working Papers and we intend to examine the 1998 and 1999 data to assess the magnitude of the problem in those years.

<u>Chase River.</u> 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. Coho spawning occurs throughout the accessible reach. They also utilise a tributary, which enters the mainstem 2.8 km from the mouth. The range in Chase River discharge is approximately 0.2 to 35 $m^3 \cdot sec^{-1}$.

The Malaspina University College Hatchery was built in 1985 and smolt releases began in 1987. Releases have ranged from 8,616 to 28,948 with no consistent target (Figure 15). The mean release is 14,434. The 1999 release was 21,718. 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 since 1998. The 2000 census included tagging to estimate the survey life of spawners. Malaspina University College made the estimates in conjunction with DFO (Irvine et al. 1994).

1.2.2 Mainland

We do not have a hatchery indicator on the mainland coast of the Strait of Georgia north of the Fraser River. 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. Data from Tenderfoot Hatchery (Squamish R. system) is not used at this time due to inadequate estimates of fishing mortality in the river system.

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 had tagged groups 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 used to be unaccounted for, due to a large freshwater sport fishery that has developed on the river. 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 the catch was hatchery-origin. This fishery was not assessed between 1988 and 1998. The catch estimate for 1998 was 12,000 jack and adult coho [revision pending] and the preliminary 1999 estimate is 6,337 adults and 51 jacks (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 sport catch of Chilliwack Hatchery coho emphasises the need to obtain accurate freshwater catch estimates.

The 1995 brood Chilliwack coho were mass marked with a pelvic clip and subsequent broods were adipose clipped. For the 1995 brood, both pelvic and adipose-pelvic groups of tagged fish were released. The application of 40k adipose-CWT had already occurred when we decided to mass mark. 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 1997, an unknown number of fish, which were supposed to be marked only with a CWT, were mistakenly adipose clipped as well. The normal marking procedure is to mark representative fish from all run timing components with a CWT and appropriate clip before mass marking the balance of production. The clipping error was caught after the early and middle components of the run had been mass marked. Two more tag codes were applied to the late component to permit comparison of Ad-CWT and CWT-only tag codes.

In 1998, electronic detection equipment was installed at the hatchery for testing. The equipment was fully functional in 1999.

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 been enhanced in the past.

The Inch Creek coho stock has been released mainly as yearling smolts and releases have included tagged groups 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 was mass marked with a pelvic clip. Subsequent releases have been mass marked with an adipose clip. As at Big Qualicum, tagging levels were doubled for the 1995 and 1996 broods. 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. , Freshwater sport fisheries on the three stocks enhanced at Inch Hatchery were open for marked and unmarked fish retention in 1998, unlike many other lower Fraser tributaries. Since then, these fisheries have been mark retention.

1.3 FISHING MORTALITY

1.3.1 Catch Monitoring

Recreational and commercial catch estimates for 1970-1997 are from the salmon stock assessment catch database (Catch Database Spreadsheet System ver 3.4) accessed through the ALPHA computer at the Pacific Biological Station (PBS).

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, starting in 1993, budget limitations have reduced the temporal coverage. In addition, there has been erosion in the number of fisher interviews during the survey period. Prior to 1993, the creel survey was conducted 12 months of the year but it was gradually reduced to 6 months by 1996-98 (April-September). Part of October was covered in the Victoria area in 1998. In 1999 creel surveys in the Strait of Georgia, West Coast Vancouver Island (wVI) and Johnston Strait covered April-October, June-September and mid-June to mid-September, respectively. In 1999, we implemented a creel survey to cover the Victoria winter chinook fishery from November to March. In 2000, we expanded the wVI creel coverage to encompass Kyuquot and Quatsino sounds. Recreational catches are not estimated elsewhere except in the lower Fraser. The lower Fraser survey was done in the mainstem in 1995 and 1996 but it was not designed for coho catch monitoring and terminated in September each year, before most returning coho were available in the river. Nor did the 1995-6 surveys cover the intense local sport fishery directed at Chilliwack Hatchery coho in the Chilliwack/Vedder River. However, there were separate creel surveys there in 1985, 1986, 1988 and since 1998. Nicomen/Norrish, Harrison, Chehalis and Stave systems have also been surveyed since 1998.

Other recreational catch monitoring activities were instituted in 1998 and 1999 (logbooks and independent observers). The objective was to augment the on-going catch and release information and to provide better and more timely in-season coho management. A release mortality of 10% was applied to the number of coho encounters in the sport fishery to estimate hooking mortality. The overall goal of these programs was to avoid coho by-catch and reduce the mortality associated with catch and release. Since retention of mass marked fish will be allowed in some fisheries in 2001, all coho will be electronically checked for cwt's (‘wanding’).

Up to 1997, most commercial catch was well estimated through the commercial sales slip system. However since 1998 severe coho conservation measures have been imposed to protect upper Skeena (initially) and Thompson stocks at times and places where they were prevalent. Because of non-retention restrictions imposed in most fisheries in these years, the mortality associated with releasing coho was assessed by mandatory logbook programs (both written and phone-in) and through observer programs that directly monitored and verified the encounter and release information provided by fishermen in the logbook program. Fishing mortalities are based on kept coho, where permitted, plus encounters multiplied by assumed release mortality rates of 26%, 25% and 60% for troll, seine and gillnet fisheries. Aboriginal catches of coho are not well recorded before 1999 but coverage has been improving.

1.3.2 Catch, Survival and Exploitation Analyses

Previously, estimates of fishing mortality were made two ways (Simpson et al. 2000). The first was the standard method of using coded wire tag recoveries. The second used stock identification through DNA analysis to apportion by stock the estimates of coho release mortalities in each fishery. To obtain estimates of exploitation, the DNA method also required estimates of total escapement to the regions used in the stock identification analysis. Survival estimates would also require regional estimates of smolt production but these estimates are too unreliable to use. DNA sample sizes were too small to generate reasonably precise stock compositions for some fisheries and they were not randomly collected. Finally, we recognised that the estimates of regional escapement were very unreliable. Consequently, we concluded that the problems with the DNA-based analysis are too severe for Georgia Basin coho to warrant inclusion in this report.

The reason the DNA approach was originally adopted was that the CWT data in the present regime of very small catches is also inadequate, largely because it does not include estimates of coho that died as a result of capture (usually termed ‘release’ mortality but it includes pre-release as well as post-release mortality). The resultant under-estimation of exploitation becomes significant in relative terms when catch is small and retention restrictions increase release rates, as in 1998 to 2000. It also results in underestimates of survival.

This gap is most significant for Black and Salmon coho, none of which were marked and thus went undetected in fisheries. Holtby et al. (2000) assumed the number of unmarked coho from Black Creek that were encountered by sport fishermen was at least equal to the retention (catch) of marked Quinsam coho groups. Black and Quinsam coho have shared the same catch distribution in the past (Simpson et al. 2000). Since virtually all Canadian exploitation was from sport fisheries, many of which were mark selective fisheries, they calculated a minimum fishing mortality of Black coho equal to the exploitation in Alaska plus 10% of the Canadian exploitation (10% being the assumed release mortality). Exploitation in Washington was not included because this data is not available yet. Similarly, mortality estimates for Salmon River coho were derived from estimates of exploitation rate of Inch Hatchery marked coho, which have had virtually the same ocean catch distribution in earlier years (Simpson et al. 2000). These mortality estimates are incomplete because the encounters of marked coho that were released are not known.

1.4 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 2000 and speculate on the same for 2001.

The Georgia Basin fry survey began in 1991. Streams were sampled in the early fall during September, 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). The sampled streams are shown in Figure 1. We tried to sample the same sites each year although there are some deletions and additions to the survey each year.

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.

Most sampled reaches were 20 to 35 m long. The reach was isolated with barrier nets and the abundance of coho fry was estimated using a removal technique, usually three pass, with equal shocking and netting effort in each pass (Seber and LeCren 1967). 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. parr. Most catches consist of >95% underyearlings (age 0. fry). Densities were expressed in this report as numbers of fry per m of reach length. This measure 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 from all coho and scales were taken from coho 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.

All data are shown but spatial and temporal comparisons were made using a sub-sample of sites. Data were selected for the sub-sample 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.

1.5 ESCAPEMENTS

1.5.1 Data Collection

Coho adults were counted approximately weekly, via foot and swim surveys through the main coho spawning period (October to between the end of December and mid-January). Figure 2 shows the locations of spawner enumerations. The counts are used to generate area-under-the-curve (AUC) estimates of escapement (e.g. Irvine et al. 1993). 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. In almost all cases, most or all the length of stream utilised by spawners was covered and the same reach was surveyed each year. Estimates of the proportion of the entire stream population in the surveyed reaches were not used because this information was rarely available and the primary goal of the surveys has been to detect escapement trends and we have made the common assumption that spawning distributions are not highly variable from year to 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.

Approximately six tributaries in the Cowichan River system have been systematically visited since 1989. Virtually all other streams were only covered thoroughly enough to generate useful AUC estimates beginning in 1998. Charter patrolmen and stewardship and Native groups outside the Squamish to Hope area (Lower Fraser/Lower Mainland or LFLM) collect escapement information on other streams but the amount of data is inadequate to estimate a coho escapement and some stocks are heavily enhanced. AUC estimates were obtained for 37 populations in 1998, 50 in 1999 and 54 in 2000.

None of the LFLM populations have had plants of hatchery fry but others have: 11 of the escapements monitored on Vancouver Island may have had enhanced components in 1998 and 15 escapements on Vancouver Island and the Sunshine Coast were possibly enhanced in 1999 (plus the Village Bay population, which was counted through a fence). The number of enhanced stocks surveyed in 2000 was 18. Estimated enhanced contributions to escapement were calculated for each fry plant by assuming survivals to smolt of 10%, 15% and 30% for early spring plants of unfed fry, spring/early summer plants of fed fry and fall plants of fry, respectively. These values approximate the values used by the Habitat and Enhancement Branch (‘SEP Bio-standards’), which are based on reviews of measured survivals. The survival of smolts originating from fry plants was assumed to be equal to the survival of Black Creek coho for the year. Some stocks received hatchery smolts and their contributions to escapements were estimated by applying the smolt to escapement survival of Big Qualicum Hatchery coho for the year. There were ten stocks in 2000 that potentially had a hatchery smolt contribution to escapement.

1.5.2 Area under the Curve Analysis

Vancouver Island/Sunshine Coast Stocks

AUC abundance estimates are calculated using the time series of counts and survey lives. We used the crew's estimated, not observed, counts. The AUC calculation of escapement, N, (e.g. English et al. 1992) is:

$$N = AUC / SL \tag{1}$$

where *SL* is the mean survey life and *AUC* is the area under a plot of the numbers seen or estimated over the season:

$$AUC = 0.5\sum_{i=1}^{n}(t_i - t_{i-1}) \cdot (C_i + C_{i-1}) \tag{2}$$

where *n* is the number of counts in the season, t_i is the Julian date of the i^{th} survey and C_i is the estimated number of adult coho on the i^{th} survey (estimated numbers = observed counts / observer efficiency estimated for the day). In 1998 survey lives used on Vancouver Island streams were based on measurements in the Cowichan system and elsewhere reported in the literature. 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 from tagging studies conducted at the Mesachie Creek fence (Holtby 1993). Although difficult to measure accurately, SL's appear to be correlated with stream size – coho tend to occupy larger streams longer. The estimates for Vancouver Island/ Sunshine Coast populations used SL's graduated by stream size (Simpson et al. 1999, 2000).

Perrin and Irvine (1990) summarised estimates of survey lives, which we updated last year (Simpson et al. 2000). One conclusion of the analysis is that for the size of streams being surveyed in this area the average survey life was 14 d and the variability in observations was low. Second, the data do not negate the universal and critical assumption that AUC estimates, if not necessarily accurate estimates of absolute abundance, are at least indicators of annual trends. That is, assuming survey lives are consistent between years is an approximation that is not inconsistent with the data.

Based on this review, the South Coast Salmon Section used a standard SL of 14 d for all Georgia Basin escapements in 1999 that did not have existing SL data. Estimates of 1998 escapements were also re-calculated using 14 d as necessary. There is SL data from only a few populations in the Georgia Basin (e.g. from Cowichan tributaries and Chase River/Beck Creek).

Water levels were exceptionally low throughout the Georgia Basin during most of the normal spawning season in 2000. Populations in small streams had a bimodal entry, the first mode probably remaining in pools longer than usual. The second mode entered when rain finally occurred in the last week of November, late in the normal spawning season. These fish spawned very quickly. Populations in larger, moderate sized streams had a normal entry pattern. Consequently, SL's were adjusted in the 2000 estimates based on streamside observations (crews felt their observation efficiencies were unusually high due to the conditions) and on measurements of survey life at Chase River. Part of the first run of Chase coho were tagged in two sessions with two colours of Petersen tags and the declines in tagged coho tracked throughout the remainder of the season. The estimated mean survey life was calculated for this mode by solving for survey life in Equation (1), where *N* is the number of coho initially tagged (both sessions combined), and the AUC was calculated as in Equation (2), with *C*'s being the estimated numbers of tagged coho. The estimate obtained was 17.9 days.

The survey lives arrived at for Vancouver Island/Sunshine Coast populations were (and these estimates may be adjusted with further evaluation): 14 d for populations in moderate sized streams (unchanged from 1998 and 1999); 17.9 d for the first entry mode of populations in small streams and 9 d for the second mode in these streams.

<u>Lower Fraser/Lower Mainland Stocks:</u>

A different approach has been used in the Fraser River Salmon Section since 1998, which led to use of a shorter survey life in LFLM streams. Here the survey life of Salmon River coho is estimated from Equation (1), where *N* is the mark recapture estimate of the escapement. The *AUC* is calculated using Equation (2). Estimated numbers of coho were used, not just tagged coho. This has resulted in remarkably consistent stream life estimates of 7.4, 6.8 and 6.8 days in 1998, 1999 and 2000. Other estimates using this method are reviewed in Appendix 1 of Simpson et al.(2000). This SL estimate for Salmon was used to calculate all the AUC estimates in the LFLM area. The 2000 SL estimate was based on a complete fence count rather than a MR estimate.

As long as AUC estimates are only used to index annual trends (under the assumption of small annual variation in survey life within streams), different methods of arriving at a survey life estimate are of no consequence as long as they are consistently applied. However, other analyses which use the escapement estimates, rather than changes in the estimates, should recognise the probability of biases. Furthermore, comparisons between estimates of absolute escapement numbers in LFLM streams and other Georgia Basin streams should be made cautiously because the differences in estimating survey lives may create unreal differences in escapement.

More problematical will be the use of escapement Limit Reference Points (LRP's; DFO 2000) that depend on absolute measures of escapement, e.g. females per kilometre. This illustrates the need for regional analytical guidelines for collection and analysis of visual escapement data.

1.6 SURVIVALS AND EXPLOITATIONS

Analyses of hatchery data are for marked coho only (CWT-ad's). Off-site hatchery releases were excluded, as were other releases that have been classified in the MRP database as being unsuitable for survival estimation. Coded wire tag recoveries were obtained from the MRP Extract Generator, version 3.2.2, accessed through the ALPHA computer at PBS. All recoveries were for 'adults' only, i.e. age .1 or brood year + 3 coho. The convention of excluding age .0 catches and escapements (jacks) is based on very low catches of this group and often poor escapement data. Estimated recoveries were used. These are the observed recoveries multiplied by the catch: sample ratio. 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 low precision).

Minimum fishing mortality estimates for the Salmon and Black wild stocks, which were not marked, were estimated as explained in Sect. 0 and the tagged components of their escapements were determined using hand-held CWT detectors (wands). All fence captures and all spawning ground carcasses and captures were wanded at Black Creek. The spawning ground sample included coho that had not been sampled at the fence when the fence was inoperable (as indicated by the absence of a fence tag or mark). The proportion of CWT coho in this spawning ground component plus the fence sample was applied to the mark recapture estimate of total escapement to estimate the tagged escapement. A portion of the fence captures at Salmon River were wanded to obtain the tag rate, which was applied to the mark recapture estimate to get tagged escapement. For 2000, it was applied to the fence count, not the MR estimate.

The estimates of CWT incidence at the Black Creek fence were probably accurate in 1999 and 2000, the first years when coded wire tagged coho returned without an adipose clip. There were 10 recoveries in 1999 on the spawning grounds that had a fence tag and all had CWT's. All had been recorded at the fence as having CWT's using the electronic detector. There were 28 recoveries of fence tagged coho on the grounds in 2000, 27 with CWT's and one without. The presence or absence of a CWT was correctly established at the fence in all 28 fish.

2. STOCK STATUS UPDATE

2.1 JUVENILE ABUNDANCE

2.1.1 Fry

Fry densities were highest for the 1990 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 decreased again to about four fry/m in 1996 and 1997 BY's (Table 1, Figure 4). Densities rebounded in 1999 (1998 BY) except on the Sunshine Coast where increases were modest, then decreased again to below average levels last year. As in most previous years, fry densities in the Sunshine Coast / Squamish area (Areas 15, 16 and 28) were less than elsewhere. Since the sample of streams is not random, area comparisons must be made carefully but densities of fry in several streams in this area have been less than we expect from our subjective assessment of habitat. Densities have been consistently between two and three fry/m for the last four years.

Summarised over the Basin, the size of fry changed little through this period except in the 1996 BY when mean fry sizes were larger, coincident with their low density (

Table 2, Figure 5). 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). Size: density correlations coefficients were negative in 41 of 50 sites where there were more than four annual estimates. Of course, density is not the only determinant of fry size and the 1997 brood (which returned in 2000) was close to the pre-1996 fry size range, even though they were almost as sparse as the 1996 brood fry. The mid-summer to mid-fall of 1998 was especially dry, which may have retarded growth. The 1998 BY fry were relatively abundant but only slightly smaller than average on the east coast of Vancouver Island and in the lower Fraser valley. Last year, the 1999 BY fry were generally below average in size but not much different than the 1997 and 1998 BY fry, despite being generally less abundant than the 1998 BY. To summarise, compared to other years, the 1997, 1998 and 1999 broods appeared to be small, large and small for their densities.

StAD intends to review the fry survey methodology and more thoroughly analyse its results. 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 merit. AUC spawner enumerations on the south coast cost about four 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 discussed in Section 0, each group shows a different escapement pattern but there is some evidence to support the notion that each is representative of a portion of the Basin. We scaled each 1990-2000 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 Figure 4.

There is a significant correlation ($r^2 = .57^*$)[1] between fry density and parental escapement (Figure 4 and Figure 6). There is no evidence of non-linearity in Figure 6 and we conclude that escapements through the 1990's, as measured in the three Basin locations, have not exceeded levels sufficient to produce maximum fall fry densities regionally. <u>Thus, surveying only one or two sites per stream once per year has provided an indication of overall trends in parental escapement</u>. On an individual stream level, Holtby showed this for Carnation Creek (Simpson et al. 1996; B. Holtby, pers. comm.). It's also seen at Black Creek and at Salmon River (Figure 7). One would expect fry to de-couple from large escapements and the largest escapements at Black Creek (1999) and at Salmon River (1993), are associated with only moderate to moderately high fry densities. With fry densities reflecting parental escapement even after the summer mortality period, an even stronger relationship is probable if fry densities were measured earlier, say after emergence. This may be a worthwhile adjunct to the fall survey, especially when escapements are sufficiently large to result in substantial density dependent mortality in the summer. Obtaining useful adult escapement counts is extremely difficult and costly through most of the coast. A spring survey should not replace the fall fry survey since the latter is useful as a 'last chance' indicator of year class strength after the summer mortality period and before winter conditions preclude this data collection.

One cannot say that the optimum escapement was exceeded at Black Creek in 1999 or Salmon River in 1993. It is possible the fry populations disproportionately utilised marginal rearing habitat when very abundant and thus were not counted. Also, late summer fry density is not a measure by itself of smolt production next spring: there is still a significant winter mortality period, which is probably inversely correlated with fry size which in turn is partly but not entirely related to their density (Holtby and Scrivener 1989). Not having escapements in the last decade large enough to produce a maximum asymptote of fry densities does not mean that these escapements as a whole were sub-optimal for producing maximum smolt production.

The below average fry densities in 2000 suggest that abundances of spawners were generally below the 10 year average in most Georgia Basin streams in 1999. That is, the relatively poor escapements to the two main indicators and Cowichan tributaries, which make up the escapement index, were collectively indicative of the general escapement status. One possibility that will be considered in the review of fry assessments will be using the fry data to define geographic coverage of escapement, smolt and fry indicators required to accurately depict the status of Georgia Basin coho. Because of its economy, the fry survey has the most geographic coverage of any assessment we do. Not all preliminary analyses are consistently favourable in this respect, however. For example, Salmon and Black escapements are not significantly correlated ($p>0.05$)

[1] * refers to $p<.05$ and $>.01$; ** refers to $p< .01$.

with fry densities the following year in the Fraser Valley and in Areas 13-14, respectively. The sample size is small, however (n=10). Nor are the fry densities at the 'Coghlan–1' site correlated with the median densities in the rest of the Fraser Valley. Densities at the 'Black-1' site are significantly correlated with the median densities for Areas 13-14 (p<.05).

2.1.2 Smolts

Wild smolts have only been enumerated for two to three years in Georgia Basin systems other than Black and Salmon (Figure 8and Table 3).

The smolt estimates at Salmon River based on mark rates of returning adults (Sect. 0) declined from the first estimate in 1986 of 294,000 to 58,000 in 1993 (Table 4). The estimates have ranged since then from 81,000 to 122,000 (Figure 8). However, there is some question regarding the accuracy of the early smolt estimates, which were based on adult recaptures. Smolts can now be estimated by recapture at the lower fence of fish that were marked upstream. The first estimates were 59,800, 86,667 and 83,374 in 1998, 1999 and 2000. The 1998 and 1999 estimates are 74% and 102% of the estimates based on the mark rate of returning adults. The average number of smolts per female at Salmon River, from BY 1987-1998, is 61 using adult recapture estimates of smolts until smolt recapture estimates were available for the last three years. This productivity is similar to that of Black Creek, a stream with similar habitat[2]. Mean smolts per female estimates based on smolt and adult recaptures are 50 and 59, respectively, but this comparison is for only two years. The 1998 and 1999 comparison of MR methods and the smolts per female data suggest that earlier smolt estimates from Salmon may have been reasonably accurate. On the other hand, the estimated number of smolts per km of mainstem length was very large in the early years. Using the mainstem length estimate of 27 km, admittedly a large underestimate of rearing length, the number of smolts per km averaged 5,319 and was over 7,000 before 1990. That is 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 (Fedorenko and Cook 1982). The average number per km at Black Creek is 1,640. This observation and the common occurrence of having lower tag rates of adults compared to the proportion of smolts tagged from April to June the year before (Sect. 0), lead us to conclude that pre-1995 estimates of smolt abundance in Salmon River were probably biased high but it is unclear by how much.

Black smolt production has not trended as strongly as the real or apparent trend in Salmon River smolts (Figure 9). The four smallest smolt runs in the 17 year record have occurred in the last five years (1993, 1994, 1996 and 1997 BY's) but in 2000 we saw the largest number recorded there, 154,326, all but an estimated 162 of which were 1998 BY age 1. smolts (Table 5).

The 1996 brood had the fewest spawners recorded but the sparse fry were large and survived exceptionally well, yielding 170 smolts/female, which compares to 65 smolts/female mean survival for the period of record (Table 5). The number of 1997 BY smolts (26,494) is the result of a low freshwater survival (41 smolts/female). The record smolt run in 2000 is the continuation of a relatively strong 1995 brood line which had a good smolt run in 1997 and a very large escapement in 1998. Despite very large fry densities in 1999, their survival was about the same as the previous brood, 42 smolts/female, and will improve further once age 2. smolts are added from the 2001 emigration. Overall, there is a fairly good relationship between the number of

[2] Salmon smolts in the smolts/female calculation are smolts by smolt year, not brood year like Black. The effect will be small.

brood year females and output of smolts (Figure 10). <u>There is no trend apparent in freshwater survivals of Black coho for the 1985 to 1998 brood years.</u>

The large increase in smolt production last year at Black Creek may be an extreme example of better than average ocean recruitment through the broader geographical area. Fry densities in 1999 were above average in all Georgia Basin areas except the Sunshine Coast and Howe Sound (Table 1).

To summarise, the smolt outputs from the Lower Mainland indicator may not have changed much since 1993 but smolts from the central Vancouver Island indicator have ranged from above average to minimal counts twice in the same period, culminating in a record high number of smolts in 2000. Both indicators are fairly productive coho systems. For Black Creek, the intrinsic productivity , i.e. the Y intercept in the regression: $\log_{10}$ (smolts/female) = f (females), is 82.7 smolts per female (95% CI: 52.0 - 131.5,Figure 11). The intrinsic productivity of Salmon R. coho is probably similar. This compares with 165 smolts/female at Carnation Cr. on the west coast of Vancouver Island (95% CI: 117 - 232) and 26 smolts/female at Snow Cr., near Port Townsend WA (Snow Cr. data are from Kadowaki et al. 1996). Considering that Black and Salmon smolt runs have frequently been below average in the last several years, we conclude that regional recruitment of wild smolts to the ocean during this period has probably also been below average. However, the 2000 ocean recruitment was probably above average generally, as mentioned above.

Over the longer term, there have probably been pervasive declines in smolt production due to habitat losses (although perhaps not as rapid as it appears 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.

Hatchery releases in inside waters (Puget Sound, Juan de Fuca Strait and Strait of Georgia) have varied between 21.4 and 29.6 million smolts from 1989 to 1999. The Strait of Georgia production has increased fairly steadily at an average rate of 229,000/year from 7.7 million to 10.1 million in the same period (Figure 12). The 1999 smolt release from ‘inside’ areas (Puget Sd. and Strait of Georgia) was 21.4 million, apparently down from the 1998 releases but this may be illusory since all the decrease was in the Washington records and perhaps records are not complete for 1999. Canadian releases have remained virtually constant at about 10 million smolts since 1996.

2.2 CATCH

About 148,000 coho were landed in 1997 in southern BC fisheries as indicated by sales slip records and creel surveys (Table 7). This was the last year when major retention fisheries occurred for coho in southern BC. Up to 1986 the annual catch generally ranged from 2.5 to 3.5 million, 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. The declining catches occurred both inside and outside the Strait of Georgia, although the relative change in catch between these areas was variable between years (Table 7).

Decreasing catches from 1990 to 1996 were due to actual declines in abundance. Firstly, exploitation rates only began decreasing in 1995 (Sect. 0). Reduced abundances may be partly the result of decreased wild smolt production but we will show below that lower smolt-to-adult survival is the over-riding cause. Wild smolt production from Black Creek and Salmon River was not trending down in this period, although their smolt production averaged less in the 1990's than in the 1980s (Figure 8 and Figure 9). Smolt releases by Washington and Georgia Basin hatcheries were not declining either (Figure 12).

These declines culminated in regulatory changes to salmon fisheries in 1998 to conserve coho populations, which were the most significant ever implemented within the Pacific Region of Canada. Since then, fisheries have been managed with an objective of zero mortality on coho stocks of most concern (interior Fraser in southern BC and initially interior Skeena in northern BC) plus a move towards more selective fishing (DFO 2000). In southern BC, prevalence of interior Fraser coho was determined by the historical frequency of capture of coho of known Thompson origin determined from an analysis of coded-wire tag data from the MRP database, plus an assessment of stock distribution from 1998 and 1999 (Irvine et al. 1999, 2000). Coho fisheries in Washington State were also reduced in 2000 relative to several years ago. A selective mark only recreational fishery was operated in Washington Management Units 5 and 6. In addition, treaty and non-treaty troll and gillnet fisheries occurred in Washington Areas 4-6 which were expected to encounter BC coho (pers. com., J.R. Irvine, DFO, Pacific Biological Station, Nanaimo).

The estimated kill of all coho in southern BC in 1998, 1999 and 2000 based on catch monitoring programs was 23,030; 30,103 and 41,232 (Table 8, pers.com., B. Shaw, DFO, 3225 Stephenson Point Rd. Nanaimo). These estimates include not only fish landings but also mortalities associated with catch and release, calculated by applying fisheries-specific mortality rates to the numbers of coho caught and released (Sect. 0). The estimated mortality of unmarked coho in WA Area 7 and in the mark selective fisheries in WA Areas 5 and 6 was 7,322. The catch of coho in the treaty and non-treaty fisheries in Areas 4 to 6 was estimated to be 5,901 (pers. comm., J.R. Irvine).

2.3 CATCH DISTRIBUTION

Prior to the major fishing restrictions imposed in 1998, Georgia Basin stocks[3] were mostly caught in the Strait of Georgia/Fraser River ('inside') sport and troll fisheries, in the "outside" troll, sport and net fisheries of wVI and in Juan de Fuca, Queen Charlotte 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 four to two 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 for years before 1998 Kadowaki et al.'s (1996) procedure of using the proportion of recoveries of tagged Georgia Basin coho in the Strait of Georgia as an indicator of inside/outside distributions before 1998. The distribution 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). Fisheries closures increased in 1998 to an extent that these data are no longer useful for estimating inside/outside distributions.

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

Detailed catch distribution (tag recovery) data are given in Tables 9 to 15 for Quinsam, Big Qualicum, Goldstream, Inch and Chilliwack hatchery stocks and Black and Salmon wild stocks. There is a key to the catch region codes in Table 6. Year 2000 includes the few recoveries made in southern BC but not recoveries in Washington, which are not yet available. All recoveries from Alaska are shown.

Recoveries before 1998 of tagged coho from these indicators, excluding Goldstream, indicate that an unusually high proportion of coho ranged out of the Strait of Georgia to wVI in 1991 and from 1994 to 1997 (Figure 13). Using proportions averaged over the six 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.

2000 was clearly another 'outside' year. The Strait of Georgia Guide Logbook project recorded only 10 legal sized coho encountered in 535 hours of fishing in Areas 17 and 18 (pers. comm., T. Carter, DFO, PBS, Nanaimo). The Georgia Strait Creel Survey estimated 3,986 legal and sub-legal sized coho encountered up to the end of August in Areas 14 to 18 (before most spawners have returned from elsewhere; pers. comm., J. Sturhahn, DFO, PBS, Nanaimo).[4] Total coho encounters up to the end of August in the Strait of Georgia sport fishery were estimated to be only 5,929; 5,580 and 11,869 in 1998, 1999 and 2000 (pers. comm., B. Shaw). Most of these would be sub-legal sized age .0 coho and coho from early returning stocks, primarily Capilano where some retention was allowed. There was an estimated catch in Burrard Inlet of 2,456 in 2000 with an estimated 380 additional encounters, leaving 9,033 encounters elsewhere in the Strait.

Forecasts of inside distribution have been reasonably successful using salinity's in the northern Strait in February and March of the return year (Simpson et al. 2001). The forecasts since 1997 suggest that the proportion of Georgia Basin coho that were in the Strait in their last ocean year changed little from 1998 to 2000 and was somewhat larger than the previous three year period, 1995 to 1997 (Figure 13). Coho in their first ocean year apparently move out of the Strait in early fall. Trawl surveys by the Fish Productivity Section, Science Branch, suggest that age .0 coho began leaving the Strait in September, 1999, which is similar to the decline in catches seen in 1997 and 1998 (pers. comm., R. Beamish, C. Neville and G. McFarlane, DFO, PBS, Nanaimo). One theory is that this always or at least usually occurs and the difference between an 'inside' and 'outside' distribution in the second year is whether coho return to the Strait in the early spring or not. The 2001 forecast is also shown for reference and the estimate is for a strong inside distribution for the first time since 1993.

[4] Encounters on the mainland shore are not discussed because the returns to Lang, Maclean Bay, and Capilano hatcheries in Areas 15, 16 and 28, respectively, complicate the picture. They are summer runs with associated retention fisheries for the latter two.

2.4 ESCAPEMENT

Interpreting escapement trends for the extensive set of streams in the Georgia Basin (Table 16) is difficult since complete escapement data largely exist only since 1998. There are difficulties with escapement assessments beyond the lack of a long time series, however. We can ameliorate their sample size limitations due to cost, for example by obtaining peak counts in a set of populations when weekly counts in another set provide timing information. However, there are more serious limitations in its use due to potentially large errors in estimating observer efficiency and survey life. How serious depends on how the data are used (Sections 0 to 0).

Both temporal and spatial comparisons will be affected if observer efficiency estimates are biased between compared entities. Since many populations are not entirely counted, all uses of escapement data must assume stable distributions of spawners within each stream, unaffected by annual changes in population size for example, or accommodate unstable distributions in some way, e.g. by models or simply by excluding partial count data. Finally, there is a difficulty, which is not confined to escapement estimates, which is estimating the effects of hatchery fry and smolt stocking. Many of the AUC estimates were obtained from populations that had received hatchery fry or smolts. Our estimates of the wild component (Table 18) should be interpreted only as indicators of possible enhancement influence and not as accurate estimates of wild coho.[5]

2.4.1 Temporal Changes in Escapement

The emphasis in this section is on annual changes in escapement but it is presented by area so this section is closely related to the next, which emphasises the spatial comparisons of temporal patterns. In the absence of annual comprehensive estimates of survey lives, temporal comparisons must assume stable survey lives within a population or group of populations between years. Although the Salmon River survey life estimates are very short compared to estimates from elsewhere (Perrin and Irvine, 1990; Simpson et al. 2000), their consistency is encouraging: the 1998-2000 estimates have been 7.4, 6.8 and 6.8 days. Other data support the assumption of reasonably low annual variation (Simpson et al. 2000).

Monitored escapements on the north-east coast of Vancouver Island, Areas 13 and 14, increased in 2000, but did not change overall in the southern areas, 17 and 18 (Table 16). There was a consistent decline in the mean relative change in escapements from Area 13 to 18 from 4.7 times to 0.7 times. The 2.2 times increase in escapement to Black Creek matched the mean increase for all monitored streams in its Statistical Area, although the extraordinarily large escapement in 1998 to Black Creek shows that data from there are not always typical of the Area.

Longer term comparisons are available from Black, Chase and Cowichan on Vancouver Island (Table 17). The estimated Black escapement of 1,114 adults in 2000 approximately equals the estimated parental brood escapement of 1,200 and is well below the long term average of 3,025 (Figure 14). Despite very low exploitation (Sect. 0) this escapement is only 35% of 3,150, which Kadowaki et al. (1995) estimated is required for maximum sustained yield. Predation by harbour

[5] Partitioning escapements as we have done is only a crude indication of potential enhancement level. Survival assumptions of planted fry are contentious and any standard is likely to be very imprecise. Since the AUC estimates are also not likely to be precise and especially since the estimates are usually of only a portion of the population, estimates of enhanced contribution often exceed the AUC estimate. Nevertheless, it should not be concluded that there was no ‘wild’ component.

seals at the mouth of Black Creek could have contributed to the low escapement to an unknown degree and one could hypothesise that depensatory mortality occurs. Delays due to unseasonably low water conditions in the fall of 2000 may have led to increased predation but this would have been a more severe problem in smaller streams entering the Strait. We have no reason to think predation rates are greater at Black than elsewhere.[6] The poor escapement of coho at Black is most likely to have been largely due to an equally poor parental brood year escapement, which produced a poor smolt run (Figure 9), which also survived poorly (Sect. 0).

Further south on Vancouver Island, the estimated Chase River escapement was 754 adults, an estimated 42% or 319 of which may have been naturally spawned ('wild') progeny of the 1997 parental brood escapement of 200, with the rest being hatchery origin (Figure 15; Table 18). The 'wild' component has changed little since 1998 and is below the long term average. This small change corresponds to equally little change in most other monitored streams in Area 17.

Further south still, the total escapement in 2000 to Cowichan River tributaries (Mesachie, Richards, Oliver, Patricia and Shaw creeks and Robertson River side channel) was 971 (Table 17). There is a complete data set for all these streams except the side channel from 1990.[7] Although better than 1999 and not substantially less than the parental brood escapement, it is a poor escapement compared to the first six years of the series despite substantial exploitations in those years. The average escapement up to 1995 was 2,769. While escapements in these streams increased in 1997 and 1998 with the virtual cessation of fishing, present levels in some of them like Mesachie and Oliver creeks are only about 13% of escapements in 1941- 44, when escapements averaged 1,852 and 462 coho, respectively (Holtby 1993; Figure 16).

Sunshine Coast escapements were not consistently larger or smaller in 2000 compared to 1999 (Table 16). A large increase of coho in Roberts Creek was probably partly due to enhancement of the 1997 brood but not the 1996 brood. We estimated that about 60% of the return may have been of hatchery origin (Table 18). Similarly, the other large increase seen in this area at Chaster Creek was probably partly due to enhancement in the second brood year (Table 18). Using the standard survivals, no 'wild' coho are assigned to this estimate. As explained above, no doubt there actually was a 'wild' component but the enhancement effect was potentially large.

<u>Our admittedly subjective assessments of habitat capacity indicate to us that stocks in Areas 15, 16 and 28 are depressed.</u> The first results from the indicator facility at Myrtle Creek, near Powell River, confirmed that escapements were very poor in 2000 (fence count of adults: 20 with 5 more sighted; Table 17). It has 8.3 km of accessible habitat and only 2,131 smolts were counted in 2000. Almost all of the length appears to be good rearing habitat. Another apparently good coho stream nearby, Whittal Creek, had only 685 smolts (Table 3). Fry in 2000 were sparse in Myrtle, although the density in Whittal was good (mean densities: 0.7 and 4.1 fry/m; Table 1). Escapements have declined from 1998 to 2000 in the three Howe Sound streams that are surveyed (Table 16).

[6] Few coho at the fence had injuries.

[7] Robertson River side channel was not surveyed from 1997 to 1999 due to habitat degradation and virtual elimination of the run. Conditions improved enough in 2000 for Robertson R. coho to utilise it.

Very little pattern can be discerned with the lower Fraser escapements since 1998 (Table 16). Escapements to Salmon River and Nathan Creek, the two streams in Area 29B (Surrey), have generally increased since 1998 and more than doubled in 2000. Area 29C (Coquitlam) escapements have shown inconsistent trends except that 2000 escapements were all less than in 1999. Most of the spawning runs in the upper part of the valley (29D and E) were also less than in 1999.

The two wild indicator stocks in the lower Fraser River continue to have independent escapement trends (Table 13; Figure 17). Simpson et al. (2000) noted earlier differences. Salmon River escapements have been trending downwards since 1995 while upper Pitt stocks have been increasing. Escapement to Salmon returned to average in 2000 from the escapement in 1999 which was the second lowest recorded. In contrast, the record high escapement to upper Pitt River in 1999 was sustained in 2000. That escapement was a 35% increase from the parental escapement and in that respect Salmon was similar: its 2000 escapement was a 25% increase over the parental escapement.

The overall temporal pattern of escapements in the Basin, as indicated by the index, which incorporates Black, Cowichan and Salmon escapements, is shown in Figure 4. The index for 2000 changed little in absolute terms from 1999, although relatively it about doubled. The index for 2000 was below the 1990's average.

2.4.2 Spatial Comparisons of Temporal Patterns

Until more data are available, spatial comparisons of AUC data must assume similar survey lives over a set of populations, perhaps varying them by suspected effects such as stream size (Simpson et al. 2000). Illustrating our lack of survey life information, estimates by the Fraser River Salmon Section of escapements in Howe Sound were made based on the survey life in Salmon River (about 7 d) while Sunshine Coast estimates, which are made by the South Coast Salmon Section mainly used a 14 d mean life, based on Vancouver Island data and data from the literature (Simpson et al. 2000). More survey life data are needed but it is difficult and expensive to obtain.

The lack of correspondence between Upper Pitt and Salmon escapements which are 50 km apart contrasts with a significant correlation between Chase escapements and those in the Cowichan system, 40 km south (Figure 18). Cowichan tributary escapements and the escapement to Chase River may be indicative of escapements to south-east Vancouver Island in general since they are significantly correlated through the time series (Figure 16).

Although Salmon River is very different from Upper Pitt River (Sections 0 and 0) and this might indicate the need for a sample of representative habitat types in assessment planning, an even broader correlation is found in wVI between Carnation Creek, Stamp River and Gold River (Dobson et al. 2000). Carnation is a small stream, very different from the other two rivers. The wVI 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 wVI 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 marine 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. More years of data are required before we can define population clusters that are sufficiently typified by each indicator stock. Fry data should be valuable for this since there is a temporally and spatially larger sample of fry populations.

Unlike 1999, when lower Fraser populations increased while other populations generally decreased, lower Fraser, Sunshine Coast and south-east Vancouver Island escapements largely remained unchanged from 1999 to 2000. Area 13 and 14 escapements were the exception, where there was a significant increase. Using the longer time series from Black Creek, Chase River, the Cowichan system, and Upper Pitt and Salmon rivers, we conclude that escapements in 2000 were probably well below longer term averages everywhere except in the lower Fraser, where escapements to Upper Pitt and Salmon were above average and average, respectively. The geometric means of estimated females/km in the lower Fraser are 54, 80 and 79 for 1998 to 2000.[8] In the rest of the Basin, the female densities are estimated to be 26, 13 and 21 for 1998 to 2000. Even if survey lives were assumed to be the same in the two parts of the Basin, female densities estimates would still have been higher in 1999 and 2000 in the lower Fraser area.

2.4.3 Comparisons to Conservation Criteria

Evaluating escapement data in relation to conservation criteria is the most demanding use of all. One criterion is the LRP, which is an estimate of the escapement density below which the risk of irreversible stock extirpation rapidly increases. This requires reasonably accurate estimates of the actual escapement to the stream, not estimates of changes in escapement. Assumptions of stable survey lives and observer efficiencies, temporally and/or spatially, are not sufficient; they must be estimated or errors accommodated in the level of the criterion. For example, a provisional LRP of three females/ km has been used recently (Stocker and Peacock, 1998; Bradford et al. 2000). That was developed using long term fence count data of relatively high accuracy and may be too low if AUC data must be relied on. Also, estimates of entire spawning populations are needed, not an index reach. And finally, the amount of habitat that may be utilised by spawners must be estimated and this data is largely absent except in the form of crude estimates of accessible length of mainstems and major tributaries.

The frequencies of streams having different levels of female escapement (females/km) from 1998 to 2000 are shown in Table 19. In 2000, as in 1998 and 1999, few streams in the Basin had fewer than three females/km. Three or fewer females per km were estimated in five streams. Two thirds had >13 females/km, which is similar to 1999 and less than in 1998.

[8] Calculated as the geometric mean of the Statistical Area/ sub-Area geometric means.

2.5 EXPLOITATION

Exploitation rates of indicator stocks are shown in Table 20 and Figure 19. These exploitation rates are determined by analysis of CWT recoveries from BC and Alaskan fisheries. Estimates for 2000 are preliminary, as Washington data are currently unavailable.

In Table 20, two exploitation rates are shown; total and marine. The marine exploitation rate excludes freshwater sport fisheries that have a significant impact on hatchery indicator stocks such as Big Qualicum, Inch and Chilliwack. In 2000, freshwater sport fisheries on Big Qualicum and Inch harvested approximately 10% of the returning population. The marine exploitation rates are more typical of what other stocks with similar ocean distribution experience. For hatchery indicators, the average marine exploitation rate in 2000 was 24%, double the estimates of 1998 and 1999. The increase was due to the opening of selective mark-only fisheries (SMF) in the Strait of Georgia in Areas 13 and 14. There were also SMF opportunities off the west coast of Vancouver Island which resulted in some harvest of Georgia Basin stocks.

Exploitation rates calculated from mark-only fisheries underestimate mortality on unmarked wild indicator stocks since CWT estimates of mortality do not include hook and release mortality suffered by unmarked fish. Using exploitation rates for marked Quinsam and Inch coho (Sect. 0), the estimated marine exploitation rate was 3.2% for Black coho and for Salmon it was 2.3%. When the SMF fisheries are highly localised, using exploitation rate from a nearby hatchery may overestimate encounters on wild stocks. However, this bias may be compensated to some extent by hooking mortality rates that do not account for either the effects of repeated hooking or longer term effects of hooking on survival and fecundity. More important, these exploitation estimates do not include mortalities suffered in non-recreational fisheries and in recreational fisheries that did not permit retention of coho. On balance, these are probably under-estimates of the actual exploitation. The preliminary estimate of exploitation for Thompson coho which attempts to include these non-documented mortalities using the DNA data is 3.4% (Irvine et al. 2001).

Another result of mass marking is an observed change in fisher behaviour with regard to the head recovery program. Over the last few years sport fishers have become aware that most ad-clipped fish do not contain CWT's. Knowing this, they have ignored head recovery programs (pers. comm., V. Palermo, DFO, 3-100 Annacis Parkway, Delta, BC). This behaviour is particularly apparent in systems where the fishery is spread over a wide geographic area. For example, in the Vedder/Chilliwack system where fishing locations may be 20km from the hatchery, no heads were voluntarily turned in. In contrast on the Inch system, where the hatchery is close by fishing locations, there were voluntary turn-ins. The result of poor response to head-recovery programs on systems like the Chilliwack/Vedder is extremely low recovery samples from which to base subsequent tag code expansions. This in turn can result in extreme sampling bias causing either over- or under-estimation of recoveries.

Overall, in 2000 exploitation rates remained well below long-term averages. These low levels were maintained by continuing restrictions on commercial fisheries that include time and area closures designed to reduce coho encounters, mandatory release of coho, and the use of selective fishing techniques. Continuing restrictions on the recreational fishery have also resulted in lower exploitation rates. Prior to the implementation of fishery restrictions in 1997, exploitation rates of Georgia Basin stocks in marine sport fisheries were significant, for example averaging 29% for Big Qualicum and 30% for Quinsam. In 2000, the marine sport exploitation rates on *marked fish* for Big Qualicum and Quinsam were 16% and 20%, respectively. SMF opportunities resulted in an average of 60% of the exploitation rate observed when restrictions were less stringent prior to 1997. Therefore, the response in effort by the recreational fishing community to expanded opportunities was not trivial.

2.6 MARINE SURVIVAL

Marine survival rates of Georgia Basin indicator stocks improved over 1999 by an average of approximately 80% for wild stocks and 50% for hatchery stocks (Table 21 and Figure 20). However, survival rates still remained well below long-term averages. The survival rates of wild indicator stocks were 2.2% for Black and 5.6% for Salmon and ranged between 1.4 to 2.3% for hatchery indicator stocks. Long-term averages are 8.8% and 8.2% for wild and hatchery stocks, respectively. These survival rates are calculated from the recovery of CWT's and are preliminary because they do no include Washington data.

Every indicator stock showed an improvement over 1999 except Inch, which declined approximately 30% from a survival rate of 2.1% in 1999 to 1.4% in 2000. Interestingly, the Salmon River indicator stock located closest to Inch had quite a dramatic increase in marine survival rates from 2.6% in 1999 to 5.6% in 2000. There is no indication of fish culture problems at Inch hatchery that may have affected marine survival rates.

Looking at the time series of available data, the pattern of survival rates is different between the mainland indicators and Vancouver Island indicators. Mainland indicators experienced high survival rates in the mid-1980s peaking with the 1985 brood year. After that, a general downward trend began. The survival rate of Vancouver Island indicator stocks began declining after the 1990 brood year, up to three years after the start of the mainland decline. (Fish culture problems at Big Qualicum in the 1980's cloud interpretation of that time series and the 1983 to 1986 brood year survivals for Big Qualicum should be given little or no weight.) For both mainland and island indictors stocks, hatchery coho continue to survive more poorly than the wild stocks, but overall trends are similar (Figure 20). The decline in average marine survival rates that began over a decade ago continued until the 1995 brood year when record low values were observed (1996 brood year for northern Basin indicator stocks Quinsam and Black). Over the last two brood years, survival rates have generally improved or stabilised but still remain poor.

In 2000, Goldstream hatchery, located on south-east Vancouver Island, began enumerating returning coho with a counting fence and mark recapture. With more complete escapement information, we can now estimate marine survival rates for this stock. For the 1997 brood year the marine survival rate at Goldstream was estimated to be 1.3%, which is similar to the survival rates observed at other Georgia Basin hatcheries.

<u>In summary, marine survival rates of coho in the Georgia Basin continued to be very poor in 2000.</u> Notwithstanding continued low values, in 1999 and 2000 average survival rates increased or stabilised for southern Basin indicator stocks (Fraser Valley and Big Qualicum River). In 2000, a modest improvement was also observed for the northern Basin indicator stocks (Black and Quinsam).

SUMMARY AND CONCLUSIONS

1. 1997 Brood. Escapements in 2000 remained poor relative to 10 year averages in all areas of the Georgia Basin except in the lower Fraser system. In terms of the provisional limit reference point of three females/km, 91% of the enumerated stocks in the Basin were above the limit. Escapements were the result of a combination of poor parental broods in 1997 and poor marine survival. Most indicators did not improve on their 1997 parental escapements.

2. Extremely low marine survival is the driving cause of current poor abundances. However, survival rates have stabilised, with virtually all indicator survivals improving at least slightly. Survival of populations on south-east Vancouver Island continue to be a concern due to low escapements observed, particularly in the Cowichan valley.

3. Largely as a result of Selective Mark Fisheries, exploitation of hatchery stocks about doubled to 24% in 2000. Exploitations of wild coho probably also increased with the increased fishing effort, though to what extent is uncertain.

4. 1998 Brood. Based on smolt estimates and fry densities and sizes, smolt runs in the Vancouver Island part of the Basin were probably above average in 2000 but continued poor on the Sunshine Coast. The number of smolts at Salmon River was not exceptional but fry densities and sizes in the Fraser Valley in 1999 suggest smolt abundances elsewhere in the area may have shown a greater improvement. Smolt runs may have been comparable to 1997, the previous smolt run in this brood line. Marine survivals and abundances in 2001 are forecast to remain about the same as in 2000 based on time series projections (Simpson et al. 2001) but the possibility of increased ocean recruitment means the forecast abundance (which we are not revising) is more likely to be an under-estimate than an over-estimate. With continued low exploitation of wild stocks, most monitored populations will probably exceed the provisional limit reference point of 3 females/km of stream as they did in 1998 and 1999.

5. Considering the current low productivity of Georgia Basin coho, we recommend that fishing mortality remain similar to existing minimal levels in order to ensure that there is a sufficient proportion of escapements that exceed the provisional limit reference point.

6. 1999 Brood. The abundance of smolts in 2000 will probably be below the 10 year average. We expect smolt numbers to remain especially poor on the Sunshine Coast. Throughout all monitored areas of the Basin, fry densities were below average in 2000. This probably resulted from low escapements in 1999. Their sizes were small despite lower densities, suggesting lower than usual over-winter survival. However, last winter was unusually dry and it is not clear what the effect this has had on freshwater survival rates.

7. Two areas of particular concern with respect to coho status are the Sunshine Coast (Area 15 and 16) and south-east Vancouver Island (Areas 18 and 19).

8. Regional rules or guidelines for the collection and analysis of escapement data are required, especially if stock assessment frameworks use Limit Reference Points of spawner abundance. The likelihood of obtaining reasonably accurate absolute, as opposed to annual index, measures of escapement needs to be carefully considered.

9. In the Lower Fraser area, the difference in escapement trends for the existing exploitation rate indicator stock, Salmon River, and the escapement indicator stock, Upper Pitt, illustrate the

need for another full indicator stock or, failing that, more smolt enumerations coupled with fry and adult estimates.

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TABLES

Table 1. Number of coho fry per meter of stream length in September from Georgia Basin sites, 1991-2000. Data in the shaded areas were selected for analysis.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	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	15.5	6.8	11.3
Black-1	9.0	22.8	15.4	7.0	13.7	19.1	2.1	5.7	15.3	8.1	11.8
Black-2						7.1	2.4				4.7
Black-3							2.9	5.3	10.1	4.8	5.8
Black-Millar					4.9	1.5	2.7	5.1	8.4	6.7	4.9
Chef-1		6.7	13.8	6.6	20.4	23.8	6.3	10.3	12.6	10.2	12.3
Chef-2						15.6	1.3	3.7	8.0	4.1	6.5
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	7.5	7.6	6.6
Cougar-2						3.5	3.3	2.8	4.5	4.4	3.7
Centre										7.5	7.5
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 - 1	5.0	3.3	1.0	5.5	3.2	4.6	2.5	1.4	5.9	2.5	3.5
Millard - 2										11.2	11.2
Morrison-1			1.5	1.0		1.4	1.7	1.4	1.5	2.8	1.6
Morrison-2					3.3	5.3	1.4	2.4	4.0	3.5	3.3
Morrison-3										0.4	0.4
Nile	28.8	10.3	6.1	2.1	5.9	6.7	3.6	7.1	7.8	17.2	9.6
Oyster		11.0									11.0
Portugese			2.7	3.4	2.1	7.6	0.9	0.0	29.3	1.8	6.0
Rosewall			1.0	0.0							0.5
Waterloo	14.0	1.6	3.9	3.1	2.5	8.7	4.4	4.5	5.0	6.3	5.4
Willow-1					7.1	8.6	5.7	5.2	11.0	4.0	6.9
Willow-2						3.7	0.5	4.1	7.0	2.8	3.6
Area 13-14 Medians:											
All data	7.9	6.7	4.1	3.4	5.8	7.2	2.7	4.3	7.9	4.8	5.8
Selected data	9.0	3.3	4.1	3.4	5.3	6.9	2.7	4.3	7.6	4.6	5.1
South East Vancouver Island (Areas 17-19)											
Beck						3.1	1.4	0.3	1.7	0.9	1.5
Bings			6.4	5.2	9.8	6.3	4.6	6.9	18.6	7.3	8.2
Bush-1		7.8	14.0	11.6	8.6	15.9	0.5	2.0	3.4	7.2	7.9
Bush-2					32.0						32.0
Bush-3						6.0	5.2	5.3	9.5	9.6	7.1
Chase-1	4.4	4.4	3.1	2.0	2.0		1.2	1.7	0.6	1.7	2.3
Chase-2		18.7	16.0	12.9	10.9		9.7	7.7	12.9	13.9	12.8
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	13.1	6.3	5.4
Halfway-2					6.6	12.4	4.0	4.1	8.5	1.1	6.1
Haslam						16.7	2.0	11.3	13.3	29.9	14.6
Head			2.8	6.3	10.5	8.3	8.6	5.3	7.4	15.8	8.1
Nanoose	3.7	4.8	6.4	10.0	10.4	10.2	2.8	8.1	9.6	16.7	8.3
Oliver-1		3.4	6.1	4.3	5.0	4.2	0.0	0.7	3.4	4.2	3.5
Oliver-2		4.2	11.1	12.0	3.9	11.4	2.0	0.7	5.8	2.6	6.0
Patricia			3.1	3.2	4.6	6.2	4.1	5.4	6.4	4.8	4.7
Richards-1			1.3	3.0	10.0	8.3	10.7	3.2	16.5	11.8	8.1
Richards-2							5.8	3.3	7.4	4.9	5.4
Whitehouse	10.2	6.6	15.2	8.6	8.3	9.5	2.1	2.0	4.1	4.2	7.1
Area 17-19 Medians:											
All data	4.8	4.7	6.1	5.2	8.4	8.3	2.8	4.1	7.4	6.3	6.6
Selected data	10.2	4.5	6.3	5.8	8.4	8.3	2.8	4.1	7.4	6.3	7.1

Table 1. (Continued) Fry densities in Georgia Basin streams.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Mean
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		48.6	25.2
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		6.5	7.9	21.0
Little Stawamus-3						3.9	12.1	2.6	28.6	8.9	11.2
Meighan	5.7	2.6	2.5	1.7						0.1	2.5
Mixal					0.9						0.9
Myers-1		8.2	0.8								4.5
Myers-2				4.9	3.1		2.9		6.4	5.6	4.6
Myers-3					5.4		4.0	2.5	4.9	6.1	4.6
Myrtle - 1										0.5	0.5
Myrtle - 2										0.3	0.3
Myrtle - 3										1.3	1.3
Okeover-1	10.9	3.4	2.5	1.8	2.2		0.2	0.8	2.3	2.8	3.0
Okeover-2		3.7	0.2	0.0	3.9		0.5	0.8	1.1	2.4	1.6
Ouillet		2.7	5.1	1.0							2.9
Whittall	35.1	19.5	10.7	11.5	4.8		1.2	2.3	2.7	4.1	10.2
Wilson-1		1.8	0.7	0.4	2.8		1.0	2.4	0.9	0.9	1.4
Wilson-2					1.6		3.3	4.4	1.8	1.4	2.5
rea 15-16,28 Medians:											
All data	10.8	9.1	6.1	5.0	6.9	(13.6)	6.1	4.4	2.7	2.6	4.1
Selected data	9.3	8.2	4.0	5.9	3.9	(15.4)	2.9	2.4	2.7	2.6	4.5
Lower Mainland (Areas 29B-E)											
Little Campbell	4.8	2.5	2.4	1.1			1.2	5.4			2.9
Lorenzetta					2.6						2.6
MacIntyre		15.0	19.6	12.1	10.9	18.3	9.6		7.7	2.1	11.9
Murray	8.0	7.7	7.1	7.9	13.4	10.0	6.8	17.5	19.8	19.0	11.7
Nathan-1	6.8	3.8	9.3	8.6	5.4	11.5	4.1	4.9	1.9	9.1	6.5
Nathan-2		5.4	15.6	17.3	10.5	10.6	7.4	33.6	22.4	14.0	15.2
Post					5.3	3.7	6.0	4.6	2.9	2.0	4.1
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	7.2	3.4	6.7
Salmon-Coghlan-2					13.9	7.3	7.2	5.5	7.2	4.9	7.7
Salmon-Coghlan-3							0.8				0.8
Siddle		11.6	26.7	22.2	19.6	11.4	14.7	11.4	30.0	17.6	18.4
Whonnock-1	2.6	2.5	6.7	3.0	5.4	4.9	5.1	4.5	6.0	1.8	4.2
Whonnock-2					4.1	6.8	4.6	3.3	8.9	5.5	5.5
Lower Mnld. Medians:											
All data	6.9	7.0	11.7	9.7	8.7	9.1	5.5	10.2	11.4	7.9	6.9
Selected data	7.4	6.5	8.2	8.2	5.4	7.3	5.1	5.2	7.2	4.9	5.7
All Data:											
Median	6.7	4.6	5.6	3.9	5.6	7.6	3.3	4.5	7.3	4.9	5.4
Mean of Area Media	7.6	6.9	7.0	5.8	7.5	8.2	4.3	5.7	7.4	5.4	5.8
Selected Data:											
Median	8.5	5.4	6.1	5.5	5.4	7.3	3.3	4.3	7.2	4.8	5.5
Mean of Area Media	9.0	5.6	5.6	5.8	5.8	7.5[2]	3.4	4.0	6.3	4.6	5.6

[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 from Georgia Basin sites, 1991 to 2000.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	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	59.4	54.0	59.3
Black-1	50.5	57.0	61.4	60.0	50.8	57.7		59.5	52.8	58.2	56.4
Black-2						73.4	73.5				73.5
Black-3							60.0	55.4	54.1	63.1	58.1
Black-Millar					59.1	58.4	61.4	56.2	53.1	53.7	57.0
Centre										47.3	47.3
Chef-1		68.8	58.8	66.6	51.7	53.9	66.5	60.4		59.4	60.8
Chef-2						55.5	70.4	57.5		57.4	60.2
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	64.7	57.9	63.8
Cougar-2						61.5	69.8	65.0	?	62.0	64.6
Kingfisher	72.4	76.2	87.6	74.4							77.7
Kitty Coleman			85.7								85.7
Menzies	71.9										71.9
Millard - 1	63.2	72.1	80.1	64.6	72.0	71.1	74.4	76.1	71.5	69.8	71.5
Millard - 2										53.3	53.3
Morrison-1			68.7	72.1		67.1	70.9	69.3	70.1	63.2	68.8
Morrison-2					63.5	55.6	64.0	59.9	61.4	55.1	59.9
Morrison-3										57.2	57.2
Nile	67.1	59.1	58.8	68.1	58.8	62.0	71.7	63.2	63.6	59.8	63.2
Oyster		82.1									82.1
Portugese			83.3	80.5	87.0	76.0	83.4	91.0	70.1	74.5	80.7
Rosewall			77.2	69.9							73.6
Waterloo	67.0	79.2	60.2	64.9	70.1	58.1	63.2	63.2	60.3	57.6	64.4
Willow-1					65.2	65.4	62.6	71.0	57.6	64.8	64.4
Willow-2						69.8	80.8	61.6	57.3	66.1	67.1
Area 13-14 Means:											
All data	64.9	68.9	69.4	66.3	63.8	63.0	68.5	64.5	61.2	59.7	65.3
Selected data	62.9	67.5	69.7	66.1	65.0	64.2	68.5	65.3	61.2	60.6	64.9
South East Vancouver Island (Areas 17-19)											
Beck						63.7	65.0	63.4	?	62.0	63.5
Bings			59.7	59.0	57.4	61.6	62.5	55.4	58.9	54.6	58.6
Bush-1		70.6	54.5	55.0	66.4	57.2	80.3	63.2	66.4	55.5	63.2
Bush-2					56.2						56.2
Bush-3						51.9	59.0	52.3	59.0	55.7	55.6
Chase-1	58.4	60.6	61.7	61.5	59.8		66.6	56.7	71.6	62.3	62.1
Chase-2		60.0	62.8	61.1	57.2		68.8	58.4	70.1	61.0	62.4
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	48.1	62.7	57.2
Halfway-2					48.5	60.6	68.7	56.1	56.3		58.0
Haslam						59.9	65.2	60.4	64.1	56.6	61.2
Head			61.2	61.0	59.3	65.3	73.4	67.5	67.1	70.4	65.6
Nanoose	69.3	59.4	63.8	57.5	60.4	59.2	70.6	61.3	65.0	60.1	62.7
Oliver-1		50.5	52.1	50.6	52.1	59.9		61.5	53.2	64.5	55.6
Oliver-2		63.6	66.8	65.8	59.9	67.8	61.8	66.0	58.3	51.6	62.4
Patricia			57.4	55.9	51.5	53.9	63.1	53.3	52.1	49.5	54.6
Richards-1			58.0	54.1	57.1	58.1	58.5	52.4	62.1	56.3	57.1
Richards-2							59.3	49.4	58.5	48.7	54.0
Whitehouse	59.4	63.9	56.0	55.0	56.8	56.6	69.1	66.8	72.0	60.9	61.7
Area 17-19 Means:											
All data	63.5	62.0	61.2	59.8	56.5	59.8	66.5	58.5	61.4	58.3	60.4
Selected data	58.8	61.0	58.8	57.9	56.2	59.8	66.3	58.6	60.1	57.8	59.2

Table 2. (Continued) Fork lengths for Georgia Basin sites.

Stream-site[1]	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Mean
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	48.7		49.6	48.4
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		50.5	60.3	55.7
Little Stawamus-3						59.2	59.8	57.5	59.2	67.0	60.5
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				56.0	52.5	54.0
Myers-3					63.6			56.9	65.3	60.1	61.5
Myrtle-1										65.6	65.6
Myrtle-2										76.2	76.2
Myrtle-3										61.3	61.3
Okeover-1	62.4	67.0	74.3	73.2	69.8			73.8	73.6	64.4	69.8
Okeover-2		59.1	67.7	62.0	51.1			58.7	63.6	56.6	59.8
Ouillet		71.8	68.2	64.6							68.2
Whittall	50.7	64.2	63.1	63.2	75.1			63.5	?	63.3	63.3
Wilson-1		74.1	78.8	80.1	58.8			56.7	68.1	63.4	68.6
Wilson-2					62.9		56.3	51.7	61.0	57.6	57.9
Area 15,16,28 Means:											
All data	59.3	64.7	67.5	63.5	58.8	55.5	54.5	58.4	62.2	61.4	63.0
Selected data	56.6	64.0	67.7	63.5	60.0	(58.2)	56.5	59.8	62.2	62.4	63.0
Lower Mainland (Areas 29B-E)											
Little Campbell	65.6	67.3	72.4	62.6			75.9	64.4			68.0
Lorenzetta					74.0						74.0
MacIntyre		53.7	51.2	51.9	53.5	48.6	53.6		59.3	58.2	53.8
Murray	74.0	56.1	69.0	51.8	57.7	65.0	76.2	62.4	59.8	61.4	63.3
Nathan-1	74.4	74.1	76.7	76.7	85.6	69.3	83.5	82.3	88.7	69.2	78.1
Nathan-2		68.0	58.8	57.5	61.4	65.1	72.7	63.0	64.3	61.8	63.6
Post					60.4	53.5	55.3	56.1	60.8	59.0	57.5
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	55.0	59.0	61.7	62.9
Salmon-Coghlan-2					57.6	58.5	68.6	60.8	62.4	60.9	61.5
Salmon-Coghlan-3							71.7				71.7
Siddle		53.0	48.6	51.2	53.8	51.7	56.9	59.0	63.5	57.3	55.0
Whonnock-1	63.6	65.1	61.4	71.0	63.9	57.8	76.0	64.6	67.7	66.0	65.7
Whonnock-2					51.1	48.5	53.0	47.1	48.7	49.1	49.6
Lower Mnld. Means:											
All data	67.0	62.8	63.0	60.2	62.3	57.8	69.4	61.5	63.4	60.5	65.2
Selected data	67.3	63.7	63.9	61.3	63.1	58.5	69.9	61.4	63.4	60.8	65.8
All Data:											
Grand Mean	63.6	64.6	65.6	62.6	60.1	60.2	67.1	61.0	61.9	59.8	63.5
Mean of Area Mean:	63.6	64.6	65.3	62.4	60.3	59.0	64.7	60.7	62.1	60.0	63.5
Selected Data:											
Grand Mean	61.6	63.9	65.0	62.0	60.9	61.0	67.4	61.5	61.5	60.3	63.2
Mean of Area Mean:	61.4	64.1	65.0	62.2	61.1	60.8	65.3	61.3	61.7	60.4	63.2

[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 3. Smolt abundances in Georgia Basin streams, excluding Black Creek and Salmon River.

Area	Stream	Enhanced?	Smolt Year				
			1996	1997	1998	1999	2000
13	Willow	N			3,699	10,636	16,192
	Simms	Y			902	2,059	4,738
	Storrie	Y			3,533	2,549	4,498
	Woods	Y			3,713	936	1,988
	Oyster	Y					92,788 [7]
14	Little	Y					33,895 [1]
	Millard	Y				(5,097) [2]	15,808
	Englishman	N			31,498	46,539	
	Centre[3]	N					6,451
17	Bush	Y					1,592
18	Cowichan L.[5]	N	9,982	16,822 [4]	2,431		7,035
	upper Cowichan[6]	N			88,462		254,976
15	Myrtle	N					2,131
	Whittal	N					685

[1] Estimated wild component was 15,509.
[2] Partial count: fence out for 1 day near peak; hole found in trap box near end of season
[3] A tributary of the Englishman River.
[4] Includes 770 from a second net.
[5] Catches of coho in a fyke net on the south shore of the lake.
[6] Mark recapture estimates based on recovery in Cowichan R. below Cowichan Lake of coho marked at the Cowichan Lake fyke net.
[7] Preliminary estimate (pers. comm., M.Sheng, DFO, 4166 Departure Bay Rd., Nanaimo)
Includes significant enhancement production: 126,000 fed fry release and 57,840 smolt release.

Table 4. Coho smolt production from Salmon River, 1984 to 1998 brood years: numbers per age and per female spawner.

Brood Year	Adult Escapement Females	Adult Escapement Total	Smolts[1] Adult MR	Smolts[1] Smolt MR	Smolts per Female[2]
1984			294,232		
1985			160,290		
1986			238,888		
1987	5,197	11,947	168,804		32.5
1988	5,779	9,152	212,923		36.8
1989	4,458	8,427	114,394		25.7
1990	3,037	4,986	153,846		50.7
1991	2,258	4,321	57,675		25.5
1992	1,013	2,604	122,000		120.4
1993	2,744	5,913	99,000		36.1
1994	781	1,941	121,000		154.9
1995	1,444	4,214	121,000		83.8
1996	1,066	2,639	81,000	59,800	56.1
1997	1,994	3,949	84,554	86,667	43.5
1998	1,368	2,993		83,374	60.9
				Mean:	60.6

[1] Smolt count of age 1. and 2. smolts in BY+2, i.e. all smolts are treated as age 1.

[2] Using smolt MR estimates since the 1996 BY.

Table 5. Coho smolt production from Black Creek, 1985 to 1998 brood years: numbers per age and per female spawner.

Brood Year	Females	Smolts Age 1.	Smolts Age 2.	Smolts Total	Total smolts per female
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	38	21,362	169.5
1997	644	26,332	162	26,494	41.1
1998	3,669	154,164	-	154,164 [1]	42.0 [1]

[1] Not including age 2. smolts (leaving spring, 2001)

Table 6. 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 7. Ocean catches of southern BC coho salmon in commercial and recreational fisheries by catch region and year, 1970 to 1997. **Catch region abbreviations are explained in Table 6.**

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
1999													
2000													

[1] FGN plus FSN

Table 7 (Continued) Coho catches

YEAR	GSPN	GSPS	JFSP	GS Sport+ JFSP[2]	ACSP	WSPT	WVI Sport[3]	Gear Totals Net	Troll	Sport	Grand Total
1970				500,000				801,283	1,220,655	500,000	2,521,938
1971				800,000				963,158	2,556,521	800,000	4,319,679
1972				335,000				358,300	1,253,650	335,000	1,946,950
1973				373,000				727,956	1,671,714	373,000	2,772,670
1974				772,000				653,029	1,977,596	772,000	3,402,625
1975				454,000				665,767	1,013,647	454,000	2,133,414
1976				415,000				519,028	2,096,545	415,000	3,030,573
1977				682,000				837,163	1,878,312	682,000	3,397,475
1978				1,103,000				391,185	1,894,299	1,103,000	3,388,484
1979				708,734				424,956	2,324,964	708,734	3,458,654
1980	291,200	86,600	15,700	393,500				382,920	2,103,948	393,500	2,880,368
1981	219,626	72,210	25,255	317,091				504,328	1,651,377	317,091	2,472,796
1982	333,700	57,996	19,990	411,686				363,669	2,040,505	411,686	2,815,860
1983	310,246	52,420	41,365	404,031				296,982	2,577,011	404,031	3,278,024
1984	318,302	83,462	41,826	443,590	2,995		2,995	227,271	2,482,354	446,585	3,156,210
1985	569,722	133,171	25,304	728,197	628	1,562	2,190	429,519	1,669,838	730,387	2,829,744
1986	442,432	94,842	34,706	571,980	1,458	1,121	2,579	390,424	2,771,227	574,559	3,736,210
1987	472,127	107,886	61,559	641,572	2,215	24,619	26,834	304,961	2,179,799	668,406	3,153,166
1988	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
1989	332,647	75,149	89,427	497,223	816	44,452	45,268	513,020	2,120,272	542,491	3,175,783
1990	493,105	67,519	69,409	630,033	334	19,843	20,177	284,273	2,192,030	650,210	3,126,513
1991	34,977	11,544	110,590	157,111	239	49,847	50,086	273,147	1,948,913	207,197	2,429,257
1992	358,494	117,328	119,732	595,554	195	37,459	37,654	204,413	1,973,536	633,208	2,811,157
1993	552,115	177,698	108,918	838,731	587	13,735	14,322	78,260	1,286,490	853,053	2,217,803
1994	147,991	28,159	118,617	294,767	19	16,378	16,397	179,732	1,338,645	311,164	1,829,541
1995	11,208	3,476	71,461	86,145	416	41,155	41,571	58,417	1,360,387	127,716	1,546,520
1996	26,737	7,139	94,014	127,890	564	25,148	25,712	11,559	795,261	153,602	960,422
1997	2,620	2,786	105,063	110,469	529	29,052	29,581	7,081	1,058	140,050	148,189
1998	128	1,219	69	1,416	0	0	0	127	0	1,416	1,543
1999											
2000											

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

Table 8. Coho encounters and associated mortalities by type of fishery in southern British Columbia, 1998 to 2000.

	1998				1999				2000			
Fishery	Encounters	% of Total Encounters	Mortality	% of Total Mortality	Encounters	% of Total Encounters	Mortality	% of Total Mortality	Encounters	% of Total Encounters	Mortality	% of Total Mortality
Commercial	21,268	14.3	8,887	38.6	4,061	3.7	1,243	4.1	19,421	17.3	6,220	15.1
Recreational	88,136	59.3	8,814	38.3	79,407	71.7	16,146	53.6	75,444	67.1	27,954 [1]	67.8
First Nations [2]	191	0.1	115	0.5	11,354	10.3	7,843	26.1	4,734	4.2	3,219	7.8
Experimental	32,020	21.6	3,270	14.2	7,765	7.0	1,765	5.9	7,793	6.9	1,867	4.5
Test Fisheries	6,910	4.7	1,945	8.4	8,121	7.3	3,106	10.3	5,118	4.5	1,972	4.8
Total	148,525	100	23,031	100	110,708	100	30,103	100	112,510	100	41,232	100

[1] Consisting of an estimated catch of 22,670 marked coho and a mortality of 5,284 unmarked coho.

[2] The difference in aboriginal encounters in 1998 and 1999 is to a large extent due to much better monitoring in 1999.

Table 9. Estimated CWT recoveries by catch region for adult coho released from Quinsam Hatchery, 1977-2000. Escapements, survivals and 'inside' catch distributions are also given.

Recovery Year		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Tagged Release[1]		168,791	97,560	159,136	168,286	226,186	280,127	57,385	102,021	147,404	57,764	57,573	42,176
Escapement		1,948	1,456	2,742	2,918	2,983	3,596	920	1,697	2,264	1,783	809	738
Catch Region:													
FWSP	FWSP	-	-	-	-	-	-	3	18	25	37	12	8
Net	CN	2,846	98	131	196	42	91	19	11	38	42	16	15
	FGN	-	7	9	6	9	13	5	6	-	9	-	-
	GSN	14	4	-	7	15	18	9	8	24	10	11	6
	JFN	67	3	5	70	143	100	2	11	90	52	39	9
	JSN	2,393	1,117	1,144	3,076	3,474	3,343	916	755	1,985	773	286	401
	NN	6	-	45	23	12	8	-	-	2	-	3	-
	NWVN	153	-	-	-	-	2	-	-	-	9	-	-
	SWVN	-	-	-	11	12	4	-	-	6	-	-	-
Sport	ACSPT	-	-	-	-	-	-	-	-	-	15	-	-
	CSPT	16	24	46	122	91	114	43	85	106	104	42	76
	GSPTN	3,121	2,258	3,217	4,802	2,095	2,369	657	1,155	4,578	1,803	1,844	1,218
	GSPTS	78	83	157	172	80	124	32	88	161	64	64	28
	JFSPT	8	21	4	-	4	25	8	32	19	9	40	34
	NSPT	-	-	-	-	-	-	-	-	3	-	-	-
	WSPT	-	-	-	8	-	4	8	4	-	4	20	-
Troll	GSTR	355	667	361	943	256	626	226	167	455	426	625	213
	NCTR	173	115	69	298	138	103	42	22	28	-	41	19
	NTR	14	83	39	133	41	49	13	10	5	14	13	19
	NWTR	272	354	463	1,203	1,015	787	369	453	357	207	178	289
	SCTR	486	637	586	1,806	1,692	1,127	664	661	588	936	261	228
	SWTR	274	198	230	682	315	693	98	352	329	152	144	48
US	Alaska	-	-	3	73	20	33	-	3	7	4	-	-
	US South	111	42	55	252	199	180	21	13	112	114	63	3
Total Return		12,335	7,167	9,306	16,801	12,636	13,409	4,055	5,551	11,182	6,567	4,511	3,352
Total Catch		10,387	5,711	6,564	13,883	9,653	9,813	3,135	3,854	8,918	4,784	3,702	2,614
Survival		7.3	7.3	5.8	10.0	5.6	4.8	7.1	5.4	7.6	11.4	7.8	7.9
Exploitation Rate		84.2	79.7	70.5	82.6	76.4	73.2	77.3	69.4	79.8	72.8	82.1	78.0
Marine Exploitation Rate		84.2	79.7	70.5	82.6	76.4	73.2	77.2	69.1	79.5	72.3	81.8	77.7
% Inside		34.6	53.1	57.4	43.4	25.7	32.4	29.4	36.9	59.2	49.5	69.8	56.1

1. After 1998, recoveries based on CWT-ad clip group only.

Table 9. (Continued) Quinsam hatchery recoveries.

Recovery Year		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Tagged Release[1]		44,457	39,362	39,466	39,400	39,411	42,470	36,277	38,947	80,125	82,531	39,813	39,322
Escapement		1,467	512	546	486	332	256	348	315	612	759	282	501
Catch Region:													
FWSP	FWSP	-	10	-	-	-	-	-	-	-	-	8	-
Net	CN	13	8	-	11	-	3	-	-	5	-	-	-
	FGN	-	-	-	-	-	-	-	-	1	-	-	-
	GSN	4	5	5	-	-	-	-	-	-	-	-	-
	JFN	71	31	88	7	-	18	31	-	-	-	-	-
	JSN	542	415	145	162	110	35	29	15	64	-	-	1
	NN	-	2	-	-	-	-	-	-	-	-	-	-
	NWVN	-	-	-	-	-	-	-	-	-	-	-	-
	SWVN	20	-	-	-	-	2	1	-	-	-	-	-
Sport	ACSPT	-	-	-	-	-	-	-	-	-	-	-	-
	CSPT	61	53	40	118	28	5	-	18	39	-	-	-
	GSPTN	1,335	1,220	101	800	660	255	58	35	12	-	47	117
	GSPTS	101	65	-	86	14	26	-	-	8	-	-	-
	JFSPT	22	16	14	11	-	18	31	21	151	-	-	-
	NSPT	-	-	-	-	-	-	-	-	-	-	-	-
	WSPT	-	-	20	-	-	11	25	32	5	-	-	12
Troll	GSTR	481	381	18	207	158	52	-	-	-	-	-	-
	NCTR	3	-	2	7	-	-	-	-	-	-	-	-
	NTR	29	5	5	-	-	-	-	-	4	-	-	-
	NWTR	262	132	196	212	38	58	109	31	-	-	-	-
	SCTR	136	143	18	156	21	12	-	-	-	-	-	-
	SWTR	120	55	373	38	6	208	245	56	-	-	-	-
US	Alaska	11	9	-	-	-	3	-	5	-	11	3	15
	US South	52	5	78	11	-	2	33	7	32	3	-	-
Total Return		4,730	3,067	1,649	2,312	1,367	964	910	535	934	772	339	646
Total Catch		3,263	2,555	1,103	1,826	1,035	708	562	220	322	14	57	145
Survival		10.6	7.8	4.2	5.9	3.5	2.3	2.5	1.4	1.2	0.9	0.9	1.6
Exploitation Rate		69.0	83.3	66.9	79.0	75.7	73.5	61.8	41.1	34.5	1.8	16.9	22.5
Marine Exploitation Rate		69.0	83.0	66.9	79.0	75.7	73.5	61.8	41.1	34.5	1.8	14.5	22.5
% Inside		59.7	65.6	11.6	60.2	80.4	47.2	11.0	16.4	-	-	-	-

1. After 1998, recoveries based on CWT-ad clip group only.

Table 10. Estimated CWT recoveries by catch region for adult coho released from Big Qualicum hatchery, 1976-2000. Escapements, survivals and 'inside' catch distributions are also given.

Recovery Year		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Tagged Release[1]		57,425	75,512	210,520	150,348	101,224	107,328	55,435	51,984	49,274	42,453	21,868	87,365	74,194
Escapement		1,392	3,450	6,456	8,287	4,861	3,561	1,177	1,128	1,233	341	63	145	231
Catch Region:														
FWSP	FWSP	-	-	-	-	-	-	-	3	12	16	-	11	-
Net	CN	302	881	256	91	68	34	15	29	-	7	-	-	5
	FGN	45	-	84	10	3	-	4	1	-	-	-	-	-
	GSN	785	88	78	82	64	148	102	301	162	213	3	15	35
	JFN	330	182	122	174	215	248	50	2	22	54	-	14	6
	JSN	1,788	1,691	4,017	1,370	1,645	1,500	872	852	299	163	3	17	87
	NN	14	10	-	7	-	-	-	-	-	-	-	-	-
	NWVN	14	14	-	-	-	-	8	-	-	-	-	-	-
	SWVN	3	-	24	7	11	1	-	-	3	-	-	-	-
Sport	ACSPT	-	-	-	4	-	-	-	-	-	-	-	-	-
	CSPT	4	8	24	34	29	16	31	22	28	6	-	11	18
	GSPTN	5,462	3,438	6,485	11,200	7,560	2,710	1,278	1,547	702	788	38	160	450
	GSPTS	405	345	1,001	1,421	899	256	149	116	69	68	-	6	43
	JFSPT	44	33	53	25	28	29	48	31	28	4	3	7	-
	WSPT	-	-	8	4	-	4	4	-	-	-	-	-	-
Troll	GSTR	980	751	3,710	3,252	1,891	649	555	43	152	173	37	69	87
	JFTR	-	3	-	-	-	-	-	-	-	-	-	-	-
	NCTR	227	55	339	56	61	68	23	17	14	-	-	-	2
	NTR	44	13	71	21	35	-	4	-	12	-	-	-	-
	NWTR	714	251	1,396	534	751	576	205	421	423	73	4	31	49
	SCTR	1,703	317	1,851	802	699	962	265	912	318	38	3	7	65
	SWTR	1,157	609	1,487	849	1,286	1,098	651	303	381	143	38	41	14
US	AK	33	-	12	9	-	-	12	-	8	-	-	-	4
	US South	1,082	275	610	248	1,415	382	270	89	25	53	-	9	16
Total Return		16,528	12,414	28,084	28,487	21,521	12,242	5,723	5,817	3,891	2,140	192	543	1,112
Total Catch		15,136	8,964	21,628	20,200	16,660	8,681	4,546	4,689	2,658	1,799	129	398	881
Survival		28.8	16.4	13.3	18.9	21.3	11.4	10.3	11.2	7.9	5.0	0.9	0.6	1.5
Exploitation Rate		91.6	72.2	77.0	70.9	77.4	70.9	79.4	80.6	68.3	84.1	67.2	73.3	79.2
Marine Exploitation Rate		91.6	72.2	77.0	70.9	77.4	70.9	79.4	80.6	68.0	83.3	67.2	71.3	79.2
% Inside		48.7	52.2	53.3	79.6	67.9	43.6	46.4	37.1	35.2	59.5	58.1	62.2	67.1

1. After 1998, recoveries based on CWT-ad clip group only.

Table 10. (Continued) Big Qualicum hatchery recoveries.

Recovery Year		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Tagged Release[1]		27,462	42,412	44,813	36,474	37,362	38,235	37,957	38,917	37,616	38,827	40,331	37,806
Escapement		138	576	846	511	647	836	496	255	348	193	431	528
Catch Region:													
FWSP	FWSP	-	8	10	5	10	77	10	15	7	16	8	67
Net	CN	-	2	-	10	-	-	-	-	-	-	-	-
	FGN	3	-	-	-	1	-	-	-	-	-	-	-
	GSN	8	50	121	29	21	10	-	-	-	-	-	-
	JFN	17	40	115	20	-	122	4	-	-	-	-	-
	JSN	12	87	45	139	103	29	13	11	13	-	-	-
	NN	-	-	-	-	-	-	-	-	-	-	-	-
	NWVN	-	-	-	-	-	-	-	-	-	-	-	-
	SWVN	-	-	9	4	1	4	1	-	-	-	-	-
Sport	ACSPT	-	-	-	-	-	-	-	-	-	-	-	-
	CSPT	-	11	35	49	37	10	3	-	18	-	-	-
	GSPTN	117	519	177	658	1,059	513	11	15	14	-	-	117
	GSPTS	-	38	-	70	92	39	2	-	-	-	-	-
	JFSPT	-	28	40	17	4	62	14	-	89	-	-	-
	WSPT	-	48	26	-	-	33	34	16	9	-		-
Troll	GSTR	11	172	14	200	376	90	-	-	-	-	-	-
	JFTR	-	-	-	-	-	-	-	-	-	-	-	-
	NCTR	-	-	-	7	-	-	-	-	-	-		-
	NTR	-	-	-	-	6	-	-	13	-	-		-
	NWTR	12	100	338	234	77	158	145	125	-	-	-	-
	SCTR	-	54	23	51	27	2	6	-	-	-	-	-
	SWTR	34	46	756	117	28	632	366	157	-	-	-	-
US	AK	-	-	2	-	4	-	5	3	-	4	3	-
	US South	4	35	201	14	4	-	12	11	37	10	-	-
Total Return		356	1,814	2,758	2,135	2,497	2,617	1,122	621	535	223	441	712
Total Catch		218	1,238	1,912	1,624	1,850	1,781	626	366	187	30	11	184
Survival		1.3	4.3	6.2	5.9	6.7	6.8	3.0	1.6	1.4	0.6	1.1	1.9
Exploitation Rate		61.2	68.3	69.3	76.1	74.1	68.1	55.8	58.9	34.9	13.5	2.4	25.8
Marine Exploitation Rate		61.2	67.8	69.0	75.8	73.7	65.1	54.9	56.5	33.6	6.3	0.6	16.4
% Inside		59.8	61.0	11.2	57.8	83.2	37.7	2.2	4.4	-	-	-	-

1. After 1998, recoveries based on CWT-ad clip group only.

Table 11. Estimated CWT recoveries by catch region for adult coho released from Goldstream hatchery, 1999-2000. Escapement and survival rates are also given.

Recovery Year		2000
Tagged Release		30,166
Escapement		374
Catch Region:		
Net	JSN	1
US	Alaska	3
Total Return		378
Total Catch		4
Survival		1.25
Exploitation Rate		0.01

Table 12. Estimated CWT recoveries by catch region for adult coho released from Inch hatchery, 1986-2000. Escapements, survivals and 'inside' catch distributions are also given.

Recovery Year		1986	1987	1988	1989	1990	1991	1992	1993
Tagged Release[1]		38,711	38,774	19,723	19,504	27,458	38,019	29,367	31,629
Escapement		516	550	453	677	306	516	693	545
Catch Region									
FWSP	FWSP	10	12	39	19	5	15	10	11
Net	CN	-	-	-	-	-	-	-	-
	FGN	32	-	39	-	31	72	38	-
	FSN	4	-	-	-	-	-	-	-
	GSN	9	19	7	-	4	-	2	2
	JFN	58	97	12	142	74	169	41	-
	JSN	29	45	46	13	25	-	23	24
	SWVN	2	13	8	22	-	4	6	-
Sport	CSPT	6	19	8	-	14	7	12	18
	GSPTN	521	907	1,462	411	535	35	502	881
	GSPTS	189	354	550	152	165	123	294	321
	JFSPT	7	35	37	22	44	50	50	16
	WSPT	-	2	-	-	-	-	-	-
Troll	GSTR	556	647	846	91	271	43	349	589
	NCTR	-	-	-	3	-	-	16	-
	NTR	-	16	-	-	-	-	-	-
	NWTR	74	106	71	17	90	214	293	58
	SCTR	88	60	16	10	15	5	36	3
	SWTR	296	410	288	326	408	1,097	386	100
US	AK	-	-	-	-	-	3	-	-
	US South	164	177	133	219	216	337	108	40
Total Return		2,561	3,469	4,015	2,124	2,203	2,690	2,859	2,608
Total Catch		2,045	2,919	3,562	1,447	1,897	2,174	2,166	2,063
Survival		6.6	8.9	20.4	10.9	8.0	7.1	9.7	8.2
Exploitation Rate		79.8	84.1	88.7	68.1	86.1	80.8	75.8	79.1
Marine Exploitation Rate		79.5	83.8	87.7	67.2	85.9	80.3	75.4	78.7
% Inside		67.7	69.9	84.3	54.1	57.9	11.0	55.9	89.0

1. After 1998, recoveries based on CWT-ad clip group only.

Table 12. (Continued) Inch hatchery recoveries.

Recovery Year		1994	1995	1996	1997	1998	1999	2000
Tagged Release[1]		21,172	20,303	21,540	21,174	38,707	41,918	60,313
Escapement		259	253	150	146	178	665	608
Catch Region								
FWSP	FWSP	10	10	30	7	16	144	67
Net	CN	-	5	-	-	-	-	-
	FGN	7	-	-	-	-	-	-
	FSN	-	-	-	-	-	-	-
	GSN	-	-	-	-	-	-	-
	JFN	107	25	2	-	-	-	-
	JSN	3	13	-	1	1	-	-
	SWVN	3	-	-	-	-	-	-
Sport	CSPT	-	-	-	-	-	-	-
	GSPTN	184	9	25	-	-	-	-
	GSPTS	48	97	26	-	16	23	159
	JFSPT	28	21	48	12	-	-	-
	WSPT	5	10	-	-	-	-	-
Troll	GSTR	88	-	-	-	-	-	-
	NCTR	-	-	-	-	-	-	-
	NTR	-	-	-	-	-	-	-
	NWTR	36	56	115	-	-	-	-
	SCTR	-	-	-	-	-	-	-
	SWTR	502	577	389	-	-	-	-
US	AK	-	-	-	-	4	-	-
	US South	8	39	50	59	28	-	-
Total Return		1,288	1,115	835	225	243	832	834
Total Catch		1,029	862	685	79	65	167	226
Survival		6.1	5.5	3.9	1.1	0.6	2.0	1.4
Exploitation Rate		79.9	77.3	82.0	35.0	26.9	20.1	27.1
Marine Exploitation Rate		79.1	76.4	78.4	31.9	20.1	2.8	19.1
% Inside		31.7	13.0	8.4	-	-	-	-

1. After 1998, recoveries based on CWT-ad clip group only.

Table 13. Estimated CWT recoveries by catch region for adult coho released from Chilliwack hatchery, 1983-2000. Escapements, survivals and 'inside' catch distributions are also given.

		1983	1984	1985	1986	1987	1988	1989	1990	1991
Recovery Year		1983	1984	1985	1986	1987	1988	1989	1990	1991
Tagged Release[1]		54,665	28,502	100,841	27,851	129,770	59,935	68,658	39,250	39,801
Escapement		1,505	1,602	5,297	949	5,325	1,859	1,947	960	990
Catch Region:										
FWSP[2]	FWSP	*392*	*140*	*459*	*169*	*677*	*255*	*453*	*145*	*101*
Net	CN	13	-	2	-	5	-	-	-	-
	FGN	76	16	263	76	142	247	47	52	18
	FSN	-	-	-	11	-	7	-	-	-
	GSN	48	5	142	18	48	5	-	5	-
	JFN	14	29	278	48	609	36	524	145	196
	JSN	571	72	238	25	170	163	90	58	27
	NN	4	-	-	5	-	-	-	-	-
	SWVN	-	-	4	-	14	16	116	-	-
Sport	CSPT	18	-	13	4	24	69	11	-	7
	GSPTN	1,142	432	4,402	740	5,045	3,877	1,576	940	33
	GSPTS	340	213	1,205	157	1,209	952	570	147	37
	JFSPT	26	12	30	7	202	68	81	32	41
	WSPT	-	4	-	-	57	-	63	19	20
Troll	GSTR	366	316	3,126	537	2,846	1,788	339	520	6
	JFTR	-	1	-	-	-	-	-	-	-
	NCTR	32	13	4	8	11	6	4	3	-
	NTR	37	-	16	-	98	6	9	5	5
	NWTR	337	237	506	145	1,270	321	430	312	437
	SCTR	500	92	83	62	363	93	19	56	14
	SWTR	820	837	1,636	584	3,089	687	1,624	611	1,251
US	AK	12	3	4	-	8	-	3	-	2
	US South	290	91	1,175	169	1,309	411	741	173	420
Total Return[2]		*6,543*	*4,115*	*18,883*	*3,714*	*22,521*	*10,866*	*8,647*	*4,183*	*3,605*
Total Catch[2]		*5,038*	*2,513*	*13,586*	*2,765*	*17,196*	*9,007*	*6,700*	*3,223*	*2,615*
Survival[3]		*12.0*	*14.4*	*18.7*	*13.3*	*17.4*	*18.1*	*12.6*	*10.7*	*9.1*
Exploitation Rate[5]		*77.0*	*61.1*	*71.9*	*74.4*	*76.4*	*82.9*	*77.5*	*77.0*	*72.5*
Marine Exploitation Rate[6]		*71.0*	*57.7*	*69.5*	*69.9*	*73.3*	*80.5*	*72.2*	*73.6*	*69.7*
% Inside		42.4	42.1	73.1	59.1	59.8	79.3	45.1	55.3	3.6

[1] After 1998, recoveries based on CWT-ad clip group only.
[2] FWSP recoveries in the Vedder/Chilliwack rivers were significant under-estimates before 1999 (see text)
[3] Survivals before 1999 are under-estimated due to under-estimation of return (footnote 2)
[4] Total exploitations before 1999 are under-estimated due to under-estimation of total catch and return (footnote 2)
[5] Marine exploitations before 1999 are over-estimated due to under-estimation of total return (footnote 2)

Table 13. (Continued) Chilliwack hatchery recoveries.

Recovery Year		1992	1993	1994	1995	1996	1997	1998	1999	2000
Tagged Release[1]		39,500	39,797	39,673	39,654	39,808	36,256	74,456	37,282	82,059
Escapement		643	420	611	548	608	600	879	447	1,463
Catch Region:										
FWSP	FWSP	*44*	*111*	*102*	*36*	*81*	*94*	*41*	91	452
Net	CN	-	-	-	-	-	-	-	-	-
	FGN	10	12	12	9	-	3	1	-	-
	FSN	-	-	-	-	-	-	-	-	-
	GSN	3	8	-	-	-	-	-	-	-
	JFN	49	4	67	39	-	4	-	-	-
	JSN	42	24	6	-	7	6	1	-	-
	NN	-	-	-	-	-	-	-	-	-
	SWVN	2	1	-	-	-	-	-	-	-
Sport	CSPT	-	10	5	3	-	9	-	-	-
	GSPTN	416	709	242	2	25	-	-	-	4
	GSPTS	134	132	42	-	7	-	25	-	-
	JFSPT	16	4	56	7	104	68	-	-	
	WSPT	21	-	18	10	18	27	-	-	-
Troll	GSTR	230	465	63	-	-	-	1	-	-
	JFTR	-	-	-	-	-	-	-	-	-
	NCTR	-	-	-	-	-	-	-	-	-
	NTR	-	-	-	-	-	3	-	-	-
	NWTR	282	137	237	118	214	-	-	-	-
	SCTR	40	5	2	6	-	-	-	-	-
	SWTR	257	232	1,055	600	449	-	-	-	-
US	AK	-	-	3	-	6	-	2	3	2
	US South	56	86	16	102	65	85	51	-	-
Total Return[2]		*2,245*	*2,360*	*2,537*	*1,480*	*1,584*	*899*	*1,001*	541	1,921
Total Catch[2]		*1,602*	*1,940*	*1,926*	*932*	*976*	*299*	*122*	94	458
Survival[3]		*5.7*	*5.9*	*6.4*	*3.7*	*4.0*	*2.5*	*1.3*	1.5	2.3
Exploitation Rate[5]		*71.4*	*82.2*	*75.9*	*63.0*	*61.6*	*33.3*	*12.2*	17.4	23.8
Marine Exploitation Rate[6]		*69.4*	*77.5*	*71.9*	*60.5*	*56.5*	*22.8*	*8.1*	0.6	0.3
% Inside		51.9	74.9	19.2	0.3	3.9	-	-	-	-

[1] After 1998, recoveries based on CWT-ad clip group only.
[2] FWSP recoveries in the Vedder/Chilliwack rivers were significant under-estimates before 1999 (see text)
[3] Survivals before 1999 are under-estimated due to under-estimation of return (footnote 2)
[4] Total exploitations before 1999 are under-estimated due to under-estimation of total catch and return (footnote 2)
[5] Marine exploitations before 1999 are over-estimated due to under-estimation of total return (footnote 2)

Table 14. Estimated CWT recoveries by catch region for adult coho tagged from the Salmon River (LWFR), 1979-1981. Escapements, survivals and 'inside' catch distributions are also given. 1987-2000 return years continued on the next page.

Recovery Year		1979	1980	1981
Tagged Release		13,473	31,965	30,232
Escapement		-	-	1
Catch Region:				
FWSP	FWSP	-	-	4
NET	CN	-	11	-
	FGN	-	140	-
	FSN	-	-	-
	GSN	-	3	18
	JFN	23	100	118
	JSN	24	49	240
	SWVN	-	3	1
SPORT	CSPT	-	5	-
	GSPTN	302	927	644
	GSPTS	179	401	283
	JFSPT	4	13	8
	WSPT	-	-	-
TROLL	GSTR	275	609	289
	NCTR	-	6	3
	NTR	-	4	-
	NWTR	-	43	117
	SCTR	5	25	122
	SWTR	106	484	638
US	Alaska	-	-	-
	US South	98	597	340
Total Return				
Total Catch				
Survival				
Exploitation Rate				
Marine Exploitation Rate				
% Inside		82.4	68.6	49.0

Table 14. (Continued) Salmon River (LWFR) recoveries.

Recovery Year		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Tagged Release		7,891	20,022	24,634	26,911	20,390	29,435	28,141	15,611	35,256	30,052	22,049	5,676	38,368	28,833
Escapement		373	1,102	903	801	371	730	1,079	495	1,248	982	720	141	1,005	1,686
Catch Region:															
FWSP	FWSP	7	8	-	-	-	-	-	-	5	-	-	-	-	-
NET	CN	-	2	-	2	-	3	-	-	-	-	1	-	-	-
	FGN	1	108	6	94	24	52	3	18	-	-	-	-	-	-
	FSN	-	5	-	-	-	-	-	-	-	-	-	-	-	-
	GSN	3	5	8	3	-	3	-	2	-	-	-	-	-	-
	JFN	56	33	263	43	129	39	7	66	54	2	6	-	-	-
	JSN	2	61	32	38	-	16	10	6	3	7	-	-	-	-
	SWVN	-	5	36	-	-	1	-	-	-	-	-	-	-	-
SPORT	CSPT	12	37	-	7	-	30	10	-	-	-	-	-	-	-
	GSPTN	260	1,235	529	789	10	455	403	167	-	63	10	-	-	-
	GSPTS	44	511	301	151	8	217	149	25	55	55	-	-	-	-
	JFSPT	26	-	95	36	11	60	8	32	49	113	70	-	-	-
	WSPT	16	-	26	-	26	50	-	28	19	18	5	-	-	-
TROLL	GSTR	206	680	101	563	14	397	517	57	-	-	-	-	-	-
	NCTR	-	-	-	5	-	-	-	-	-	-	-	-	-	-
	NTR	-	-	-	6	-	-	-	-	-	-	-	-	-	-
	NWTR	22	94	96	131	95	319	73	48	142	304	-	-	-	-
	SCTR	7	34	-	32	1	72	19	-	5	-	-	-	-	-
	SWTR	110	266	562	553	710	317	78	549	745	759	-	-	-	-
US	Alaska	-	-	-	-	-	3	-	-	-	7	-	-	-	-
	US South	71	205	366	224	184	74	18	-	127	73	38	3	-	-
Total Return		1,216	4,391	3,324	3,478	1,583	2,838	2,374	1,493	2,452	2,383	850	144	1,005	1,686
Total Catch		843	3,289	2,421	2,677	1,212	2,108	1,295	998	1,204	1,401	130	3	-	-
Survival		15.4	21.9	13.5	12.9	7.8	9.6	8.4	9.6	7.0	7.9	3.9	2.5	2.6	5.8
Exploitation Rate		69.3	74.9	72.8	77.0	76.6	74.3	54.6	66.8	49.1	58.8	15.3	-	-	-
Marine Exploitation Rate		68.8	74.7	72.8	77.0	76.6	74.3	54.6	66.8	48.9	58.8	15.3	1.8	0.3	2.3
% Inside		66.7	78.9	45.3	61.3	3.1	52.6	83.7	24.9	5.1	8.9	-	-	-	-

Table 15. Estimated CWT recoveries by catch region for adult coho tagged from Black Creek, 1986-2000. Escapements, survivals and 'inside' catch distributions are also given.

Recovery Year		1986	1987	1988	1989	1990	1991	1992	1993
Tagged Release		24,134	31,648	35,640	74,997	29,203	118,382	52,351	49,939
Escapement		825	531	1,278	2,502	946	2,616	1,389	637
Catch Region:									
FWSP	FWSP	5	5	-	-	-	-	-	5
Net	CN	15	19	22	32	13	21	64	11
	FGN	-	-	-	6	-	9	-	-
	GSN	6	18	6	31	44	27	23	12
	JFN	29	22	3	221	61	473	30	-
	JSN	322	274	325	1,166	354	779	529	305
	NN	-	9	-	33	-	4	-	8
	SWVN	-	-	-	9	5	6	3	-
Sport	ACSPT	-	-	-	-	-	-	-	-
	CSPT	39	12	59	64	37	231	312	110
	GSPTN	418	1,173	1,255	1,646	879	1,031	1,118	1,193
	GSPTS	19	39	75	204	37	14	99	33
	JFSPT	8	6	-	25	22	44	20	2
	WSPT	8	12	-	44	5	139	98	-
Troll	GSTR	128	467	346	209	302	75	346	319
	NCTR	23	25	40	14	25	20	80	4
	NTR	16	93	36	88	41	67	69	51
	NWTR	308	375	518	993	335	1,830	1,024	181
	SCTR	656	363	379	453	348	141	896	134
	SWTR	160	131	142	561	139	1,051	214	37
US	AK	3	4	10	21	13	38	60	97
	US South	28	47	23	191	25	412	29	17
Total Return		3,016	3,625	4,517	8,513	3,631	9,028	6,403	3,156
Total Catch		2,191	3,094	3,239	6,011	2,685	6,412	5,014	2,519
Survival		12.5	11.5	12.7	11.4	12.4	7.6	12.2	6.3
Exploitation Rate		72.6	85.4	71.7	70.6	73.9	71.0	78.3	79.8
Marine Exploitation Rate		72.5	85.2	71.7	70.6	73.9	71.0	78.3	79.7
% Inside		26.2	55.2	52.1	35.4	45.8	18.7	31.4	61.9

Table 15. (Continued) Black Creek recoveries.

Recovery Year		1994	1995	1996	1997	1998	1999	2000
Tagged Release		57,860	76,107	18,189	13,736	69,996	24,582	26,247
Escapement		586	1,495	182	235	3,085	407	575
Catch Region:								
FWSP	FWSP	-	10	-	-	-	-	-
Net	CN	17	30	-	1	-	-	-
	FGN	-	-	-	-	-	-	-
	GSN	-	-	-	-	-	-	-
	JFN	114	34	-	-	-	-	-
	JSN	185	155	9	27	6	-	2
	NN	9	11	-	-	-	-	-
	SWVN	5	1	-	-	-	-	-
Sport	ACSPT	-	-	-	-	-	-	-
	CSPT	55	66	42	16	-	-	-
	GSPTN	751	93	77	14	-	-	-
	GSPTS	38	-	-	-	-	-	-
	JFSPT	81	47	38	46	-	-	-
	WSPT	29	67	-	-	-	-	-
Troll	GSTR	189	-	-	-	-	-	-
	NCTR	13	13	-	-	-	-	-
	NTR	21	73	24	13	-	-	-
	NWTR	298	420	91	-	-	-	-
	SCTR	50	19	-	213	-	-	-
	SWTR	652	635	71	-	-	-	-
US	AK	62	203	69	5	73	-	-
	US South	8	87	6	27	49	-	-
Total Return		3,163	3,459	609	597	3,213	407	577
Total Catch		2,577	1,964	427	362	128	-	2
Survival		5.5	4.5	3.3	4.3	4.6	1.7	2.2
Exploitation Rate		81.5	56.8	70.1	60.6	4.0	-	-
Marine Exploitation Rate		81.5	56.5	70.1	60.6	4.0	1.7	2.8
% Inside		38.1	5.0	18.3	-	-	-	-

Table 16. Adult coho escapements to Strait of Georgia / Lower Fraser River extensive survey and indicator streams, 1998 to 2000.

Area	Stream	1998		1999		2000			Ratios	
		Total	Females / km	Total	Females / km	Total	Females / km	Survey Life[1]	2000/ 1998	2000/ 1999
13	Bird Cove	43	19							
	Menzies			4	1	41	10	U		9.2
	Mohan			54	9	165	28	U		3.1
	Nunn's			9	3					
	Salmon					1039	130	U		
	Sims					38	4	Fence		
	Village Bay	3500	83	105	3	380	9	Fence	0.1	3.6
	White Rock Pass	11	2							
	Willow					355	18	Fence		
	Geometric Mean	119	15	22	3	159	17		0.1	4.7
14	Black	7616	115	515	8	1114	18	Fence	0.1	2.2
	Centre					450	56	B		
	Coal	477	65	144	19	874	118	U	1.8	6.1
	Cowie	357	27	406	30	617	46	U	1.7	1.5
	Dove	48	2							
	Englishman mainstem					4650	138	U		
	Jackpot					97	11	B		
	Kitty Coleman			19	5	43	11	B		2.3
	Millard	179	60	59	20	46	16	B	0.3	0.8
	Morison	544	181			200	67	U	0.4	
	Nile	227	17	179	13	518	38	U	2.3	2.9
	Rosewall					2864	448	U		
	Storrie					7	1	Fence		
	Trent	2108	105	566	28	1348	33	U	0.6	2.4
	Tsable	1068	80	948	71	2527	107	U	2.4	2.7
	Waterloo	107	15	75	11	150	22	U	1.4	2.0
	Woods					88	6.5	Fence		
	Geometric Mean	449	39	184	17	364	35		0.8	2.2
15	Myrtle					25	1	Fence		
16	Anderson			99	24	116	28	B		1.2
	Chaster			11	2	50	9	B		4.5
	Halfmoon			34	57	7	12	U		0.2
	Haskins			83	119	48	69	U		0.6
	Langdale			10	10	18	18	U		1.8
	Mixal			106	76					
	Myers			79	26	23	8	U		0.3
	Roberts			18	15	256	213	U		14.2
	Wilson			79	14	132	23	U		1.7
	Geometric Mean			42	23	48	25			1.3
17	Beck	226	42	65	12	91	17	U	0.4	1.4
	Bonell	91	10	132	14	100	11	B	1.1	0.8
	Bonsall	334	21	386	24	1049	66	U	3.1	2.7
	Bush	112	23	72	15	98	20	B	0.9	1.4
	Chase	349	39	455	51	754	84	B	2.2	1.7

(Continued)

Table 16. (Continued)

Area	Stream	1998 Total	1998 Females / km	1999 Total	1999 Females / km	2000 Total	2000 Females / km	2000 Survey Life[1]	Ratios 2000/ 1998	Ratios 2000/ 1999
17	Departure			4	2	2	1	U		0.5
(contd)	Millstone			33	7	60	13	U		1.8
	Nanoose	386	34	469	42	794	71	U	2.1	1.7
	North Nanaimo			130	18	91	13	U		0.7
	Rockey			12	15	5	6	U		0.4
	Walker	27	7	8	2	3	1	U	0.1	0.4
	Geometric Mean	221	21	86	12	87	13		0.9	1.0
18	Glenora			37	3	41	3	U		1.1
	Kelvin	71	6							
	Mesachie	602	301	107	53	234	117	U	0.4	2.2
	Oliver	109	18	106	18	6	1	U	0.1	0.1
	Patricia	627	314	192	96	238	119	U	0.4	1.2
	Richards	746	62	146	12	79	7	U	0.1	0.5
	Shaw	302	50	158	26	279	46	U	0.9	1.8
	Geometric Mean	295	57	111	21	82	15		0.2	0.7
28B	Little Stawamus	179	28	58	9	28	4	6.76 d	0.2	0.5
	Mashiter	60	38	32	20	34	21	6.76 d	0.6	1.1
	Pillchuck	433	72	233	39	139	23	6.76 d	0.3	0.6
	Geometric Mean	167	42	76	19	51	12		0.3	0.7
29B	Nathan	347	27	1,092	84	2,368	182	6.76 d	6.8	2.2
	West					1,141	41	6.76 d		
	Salmon	2,992	123	2,123	87	4,945	79	Fence	1.7	2.3
	Geometric Mean	1019	57	1523	86	2373	84		3.4	2.2
29C	Blaney	353	110	73	23	35	11	6.76 d	0.1	0.5
	Widgeon					933	133	6.76 d		
	MacIntyre	347	96	929	258	118	33	6.76 d	0.3	0.1
	Upper Pitt	8,296	127	13,427	202	12,634	214	MR	1.5	0.9
	Geometric Mean	1005	111	969	106	470	57		0.4	0.4
29D	Lagace	73	6	67	6	1,899	158	6.76 d	26.0	28.3
	Whonnock	496	34	973	68	580	40	6.76 d	1.2	0.6
	Geometric Mean	190	14	255	19	1049	79		5.5	4.1
29E	Fourteen Mile	469	293	656	410	1,502	939	6.76 d	3.2	2.3
	Hopedale	116	105	151	137	85	77	6.76 d	0.7	0.6
	Kawkawa	429	134	623	195	426	133	6.76 d	1.0	0.7
	Post	1,121	224	5006	1001	1,714	343	6.76 d	1.5	0.3
	Street	12	7	100	56	7	4	6.76 d	0.6	0.1
	Geometric Mean	199	91	499	228	231	106		1.2	0.5
All Escapements:										
	Geometric Mean	300	40	124	23	170	27		0.7	1.2

[1] Survey life:
U - unimodal escapement. Water Level did not limit entry into fresh water by spawners. AUC estimate was calculated with 14.0 days.
B - bimodal escapement. Water Level did liimit entry, so that spawner escapement entered freshwater in two groups. AUC estimate was calculated with 17.9 days and 8.9 days.

Table 17. Adult coho escapements to Strait of Georgia/Lower Fraser River indicator streams, including Black Creek and Salmon River (Langley). All except Chase River have no juvenile enhancement.

Return Year	Black	Myrtle	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
1999	515		455	107	124		106		192	158	2,123	13,437
2000	1,114	25	754	234	79		6	135	238	279	4,945	12,634

* There have been hatchery smolt releases in Chase River since 1990. See Fig. 12 for estimates of wild and enhanced escapement components.

Table 18. Estimates of wild coho escapement to Georgia Basin streams from 1998-2000. Wild coho are shown as a percent of the estimated run and number of fish.

Area	Stream	1998		1999		2000	
		%	Number	%	Number	%	Number
13	Bird Cove	84%	(36)				
	Menzies			0%	(0)	0%	(0)
	Mohun			0%	(0)	31%	(51)
	Nunn's			0%	(0)		
	Village Bay	86%	(3007)	51%	(54)	33%	(126)
	White Rock Pass	100%	(11)				
14	Black	100%	(7616)	100%	(515)	100%	(1114)
	Centre					100%	(450)
	Coal	100%	(477)	100%	(144)	89%	(777)
	Cowie	100%	(357)	99%	(401)	100%	(617)
	Dove	98%	(47)				
	Englishman mainstem					100%	(4650)
	Jackpot					100%	(43)
	Kitty Coleman			100%	(19)	100%	(97)
	Millard	78%	(139)	0%	(0)	0%	(0)
	Morison	100%	(544)			100%	(200)
	Nile	100%	(227)	100%	(179)	100%	(518)
	Rosewall					77%	(2199)
	Storrie					100%	(7)
	Trent	71%	(1500)	66%	(375)	82%	(1100)
	Tsable	84%	(899)	99%	(942)	87%	(2210)
	Waterloo	5%	(6)	93%	(70)	100%	(150)
	Woods					63%	(55)
15	Myrtle					100%	(25)
16	Anderson			100%	(99)	0%	(0)
	Chaster			100%	(11)	0%	(0)
	Halfmoon			0%	(0)	100%	(7)
	Mixal / Haskins			0%	(0)	0%	(48)
	Langdale			100%	(10)	100%	(18)
	Myers			100%	(79)	100%	(23)
	Roberts			100%	(18)	41%	(106)
	Wilson			100%	(79)	100%	(132)

(Continued)

Table 18. (Continued)

Area	Stream	1998 %	1998 Number	1999 %	1999 Number	2000 %	2000 Number
17	Beck	100%	(226)	100%	(65)	100%	(91)
	Bonell	100%	(91)	100%	(132)	100%	(100)
	Bonsall	15%	(50)	83%	(322)	94%	(990)
	Bush	100%	(112)	89%	(64)	12%	(12)
	Chase	88%	(308)	73%	(334)	42%	(319)
	Departure			100%	(4)	100%	(2)
	Millstone			0%	(0)	0%	(0)
	Nanoose	100%	(386)	100%	(469)	100%	(794)
	North Nanaimo[2]			U/K		U/K	
	Rocky			100%	(12)	0%	(0)
	Walker	56%	(15)	100%	(8)	100%	(3)
18	Glenora			100%	(37)	100%	(41)
	Kelvin	100%	(71)				
	Mesachie	100%	(602)	100%	(107)	100%	(234)
	Oliver	100%	(109)	100%	(106)	100%	(6)
	Patricia	100%	(627)	100%	(192)	100%	(238)
	Richards	100%	(746)	100%	(146)	100%	(79)
	Shaw	100%	(302)	100%	(158)	100%	(279)
28B	Little Stawamus	100%	(179)	100%	(58)	100%	(28)
	Mashiter	100%	(60)	100%	(32)	100%	(34)
	Pillchuck	100%	(433)	100%	(233)	100%	(139)
29B	Nathan	100%	(347)	100%	(1092)	100%	(2368)
	West					100%	(1141)
	Salmon					100%	(4945)
29C	Blaney	100%	(353)	100%	(73)	100%	(35)
	Widgeon					100%	(933)
	MacIntyre	100%	(347)	100%	(929)	100%	(118)
29D	Lagace	100%	(73)	100%	(67)	100%	(1899)
	Whonnock	100%	(496)	100%	(973)	100%	(580)
29E	Fourteen Mile[3]	100%	U/K	100%	U/K	100%	U/K
	Hopedale	100%	(116)	100%	(151)	100%	(85)
	Kawkawa	100%	(423)	100%	(621)	100%	(426)
	Post	100%	(1121)	100%	(5006)	100%	(1714)
	Street	100%	(12)	100%	(100)	100%	(7)

[1] Haskins but not Mixal counted in 2000.

[2] Fry plants occur in N. Nanaimo but their size is unknown at this time.

[3] Fourteen Mile Cr. is known to receive stray spawners from Chilliwack Hatchery.

Table 19. Frequency of different escapement indices of female coho salmon in Georgia Basin streams, 1998-2000.

Females/km	1998 Number (%)	1999 Number (%)	2000 Number (%)
<3	2 (5.0)	4 (7.7)	4 (6.9)
3-13	5 (12.5)	15 (28.8)	16 (27.6)
>13	33 (82.5)	33 (63.5)	38 (65.5)
Total	40 (100.0)	52 (100.0)	58 (100.0)

Table 20. Percent exploitation rates of adults from five hatchery and two wild coho stocks. Marine exploitation rates are more likely to reflect exploitation rates of wild stocks.

Return	Quinsam		Big Qualicum		Inch		Chilliwack		Goldstream		Black		Salmon	
Year	Total[1]	Marine[1]	Total	Marine	Total	Marine	Total	Marine	Total	Marine	Total	Marine	Total	Marine
1976			91.6	91.6										
1977	84.2	84.2	72.2	72.2										
1978	79.7	79.7	77.0	77.0										
1979	70.5	70.5	70.9	70.9										
1980	82.6	82.6	77.4	77.4										
1981	76.4	76.4	70.9	70.9										
1982	73.2	73.2	79.4	79.4										
1983	77.3	77.2	80.6	80.6			*77.0*	*71.0*						
1984	69.4	69.1	68.3	68.0			*61.1*	*57.7*						
1985	79.8	79.5	84.1	83.3			*71.9*	*69.5*						
1986	72.8	72.3	67.2	67.2	79.8	79.5	*74.4*	*69.9*			72.6	72.5		
1987	82.1	81.8	73.3	71.3	84.1	83.8	*76.4*	*73.3*			85.4	85.2	69.3	68.8
1988	78.0	77.7	79.2	79.2	88.7	87.7	*82.9*	*80.5*			71.7	71.7	74.9	74.7
1989	69.0	69.0	61.2	61.2	68.1	67.2	*77.5*	*72.2*			70.6	70.6	72.8	72.8
1990	83.3	83.0	68.3	67.8	86.1	85.9	*77.0*	*73.6*			73.9	73.9	77.0	77.0
1991	66.9	66.9	69.3	69.0	80.8	80.3	*72.5*	*69.7*			71.0	71.0	76.6	76.6
1992	79.0	79.0	76.1	75.8	75.8	75.4	*71.4*	*69.4*			78.3	78.3	74.3	74.3
1993	75.7	75.7	74.1	73.7	79.1	78.7	*82.2*	*77.5*			79.8	79.7	54.6	54.6
1994	73.5	73.5	68.1	65.1	79.9	79.1	*75.9*	*71.9*			81.5	81.5	66.8	66.8
1995	61.8	61.8	55.8	54.9	77.3	76.4	*63.0*	*60.5*			56.8	56.5	49.1	48.9
1996	41.1	41.1	58.9	56.5	82.0	78.4	*61.6*	*56.5*			70.1	70.1	58.8	58.8
1997	34.5	34.5	34.9	33.6	35.0	31.9	*33.3*	*22.8*			60.6	60.6	15.3	15.3
1998	1.8	1.8	13.5	6.3	26.9	20.1	*12.2*	*8.1*			4.0	4.0	-	1.8
1999	16.9	14.5	2.4	0.6	20.1	2.8	17.4	0.6			-	1.7 [3]	-	0.3 [3]
2000	22.5	22.5	25.8	16.4	27.1	19.1	23.8	0.3	1.0	1.0	-	2.8 [3]	-	2.3 [3]

[1] Total Exploitation: FWSP catch was included in the total catch. Marine Exploitation: FWSP catch was included in the escapement.

[2] Total and marine exploitation rates are under - and over - estimates, respectively, before 1999 (see text).

[3] Marine exploitation rate calculated by assuming a 10% catch and release mortality on nearby hatchery stocks exploitation rate.

Table 21. Percent smolt to adult survival rates of five hatchery and three wild coho stocks.

Return	Hatchery Indicator Stocks					Wild Indicator Stocks		
Year	Quinsam	Big Qualicum	Inch	Chilliwack[1]	Goldstream	Black	Salmon	Mesachie
1976		28.8						
1977	7.3	16.4						
1978	7.3	13.3						
1979	5.8	18.9				19.0 [2]		
1980	10.0	21.3				19.8 [2]		
1981	5.6	11.4						
1982	4.8	10.3						
1983	7.1	11.2		*12.0*				
1984	5.4	7.9		*14.4*				
1985	7.6	5.0		*18.7*				
1986	11.4	0.9	6.6	*13.3*		12.5		
1987	7.8	0.6	8.9	*17.4*		11.5	15.4	
1988	7.9	1.5	20.4	*18.1*		12.7	21.9	6.9
1989	10.6	1.3	10.9	*12.6*		11.4	13.5	4.9
1990	7.8	4.3	8.0	*10.7*		12.4	12.9	7.0
1991	4.2	6.2	7.1	*9.1*		7.6	7.8	3.2
1992	5.9	5.9	9.7	*5.7*		12.2	9.6	2.5
1993	3.5	6.7	8.2	*5.9*		6.3	8.4	2.0
1994	2.3	6.8	6.1	*6.4*		5.5	9.6	2.7
1995	2.5	3.0	5.5	*3.7*		4.5	7.0	
1996	1.4	1.6	3.9	*4.0*		3.3	7.9	
1997	1.2	1.4	1.1	*2.5*		4.3	3.9	
1998	0.9	0.6	0.6	*1.3*		4.6	2.5	
1999	0.9	1.1	2.0	1.5		1.7	2.6	
2000	1.6	1.9	1.4	2.3	1.3	2.2	5.8	

[1] Survival rates before 1999 are under-estimates due to unreported catches in the Vedder/Chilliwack rivers (see text).
[2] Probably under-estimates due to under-estimated escapements.

FIGURES

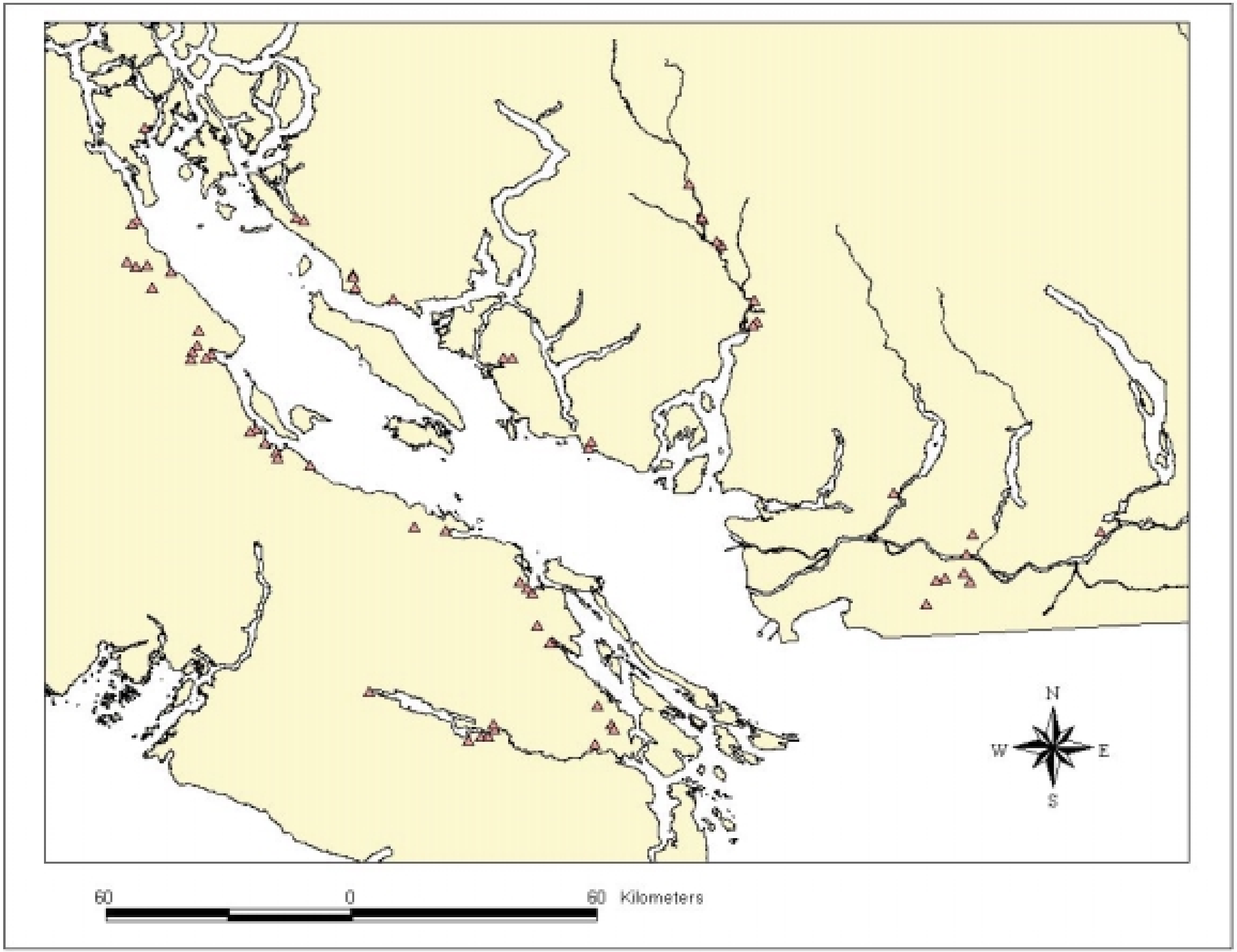

Figure 1. Locations where coho fry were enumerated and sampled in 2000.

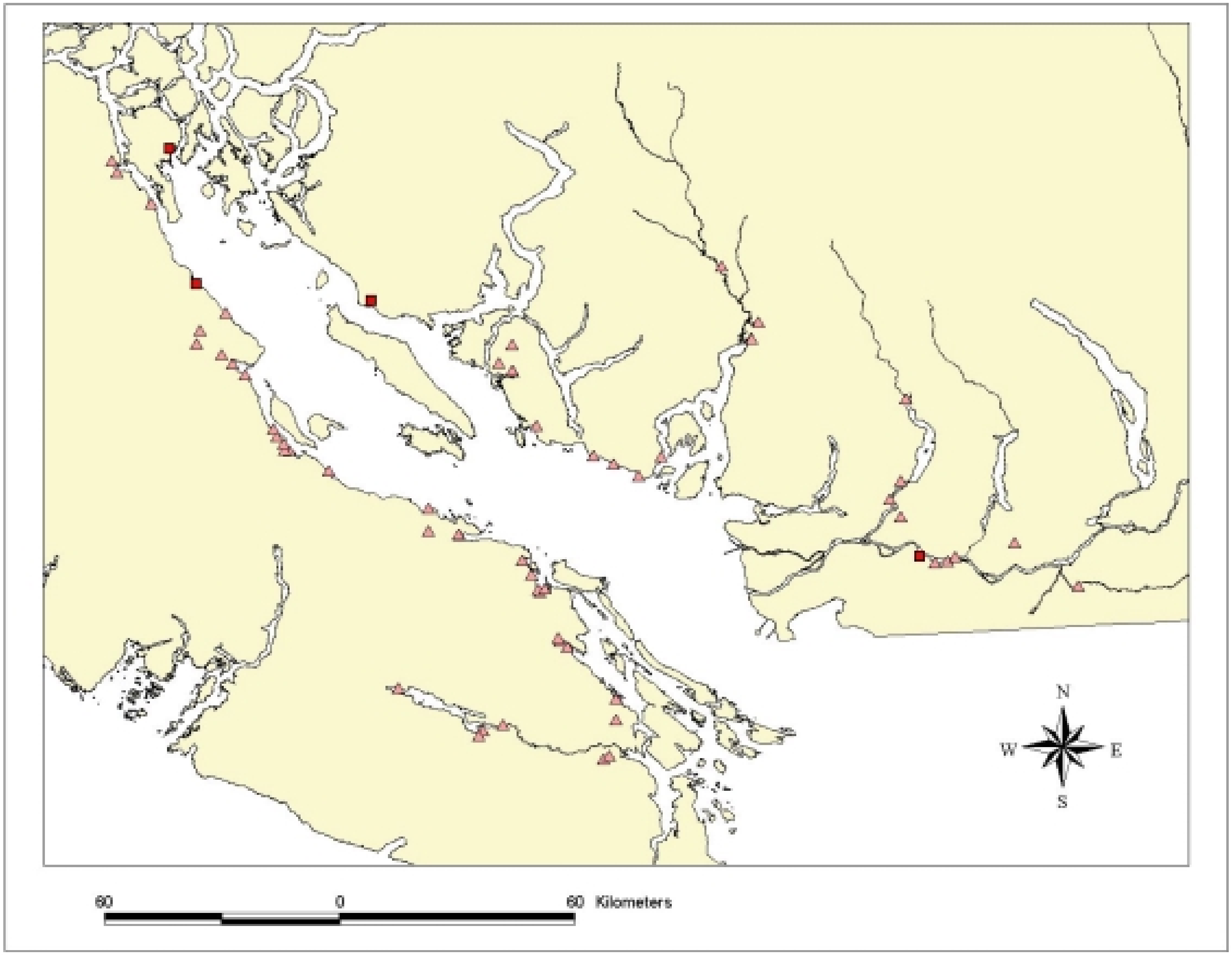

Figure 2. Locations of coho spawner enumerations in 2000. Fence count operations are denoted by squares, mobile counts (walks and swims) are shown as triangles. The Upper Pitt enumeration was a mark recapture estimate.

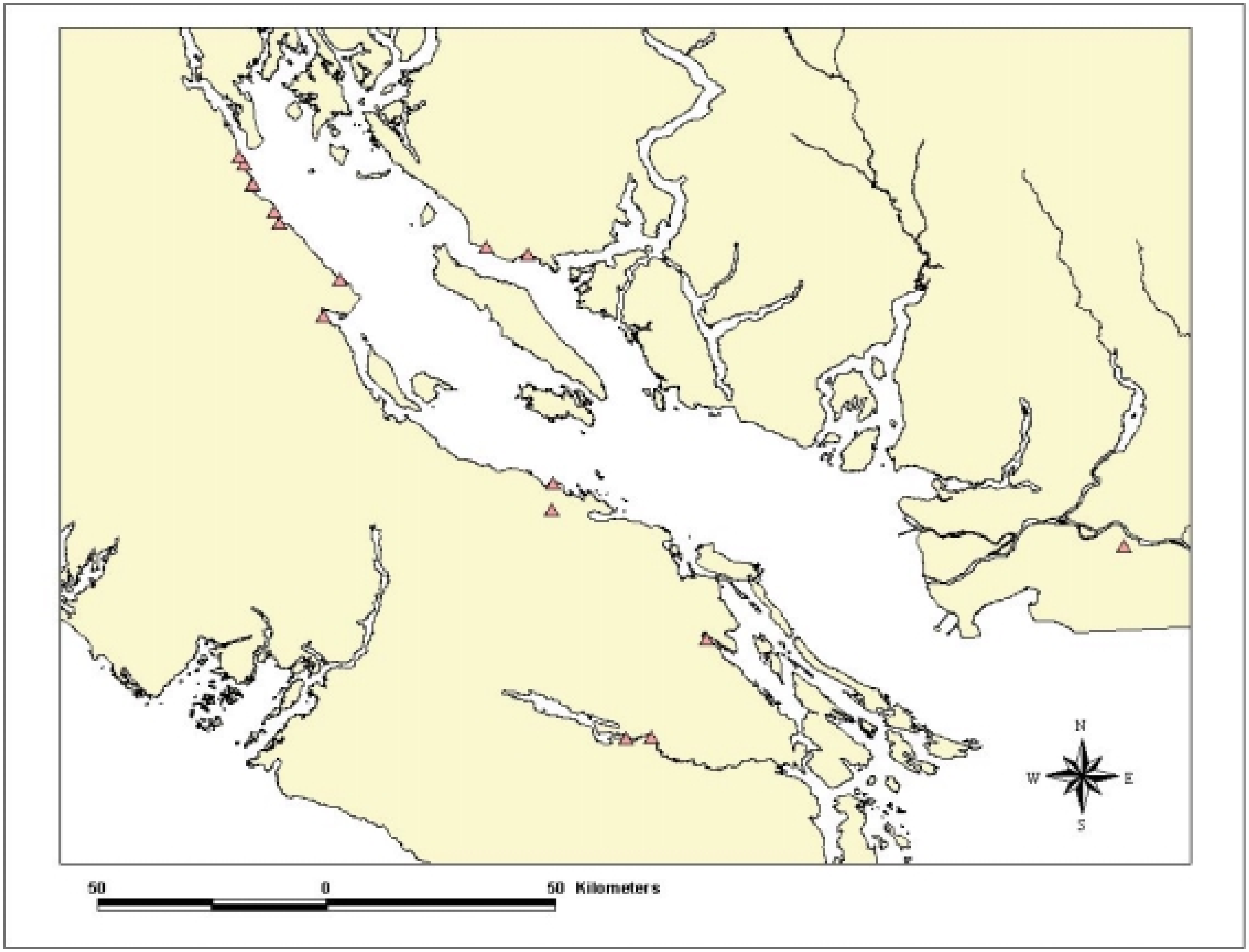

Figure 3. Locations where coho smolts were enumerated and sampled in 2000.

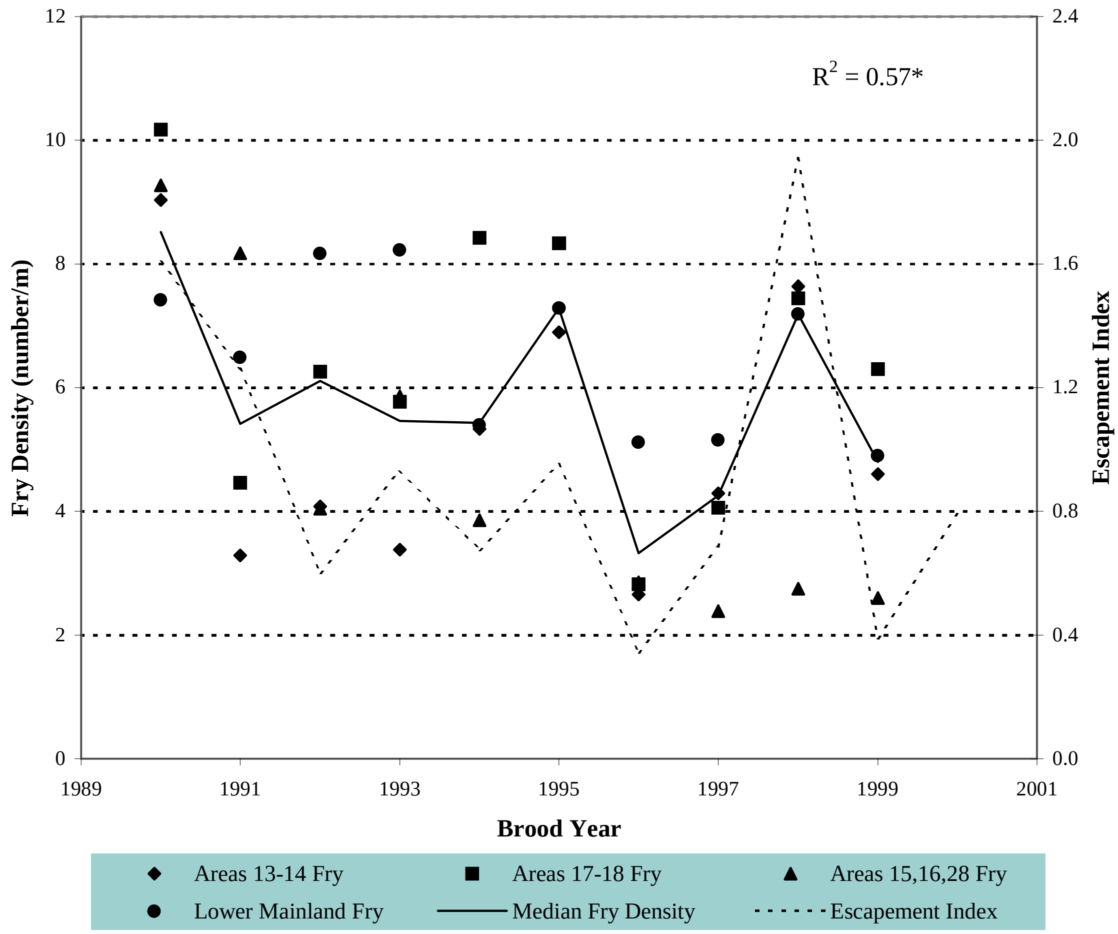

Figure 4. Median densities of coho fry in sub-areas of the Georgia Basin and an index of the parental escapement, 1990 to 2000 brood years. Density data consisted of September abundances of age 0. and 1. fry per meter of reach length in selected streams. Points are median densities for the sub-areas 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 escapement index calculation is described in the text. The R^2 figure refers to the regional escapement index: median fry density correlation.

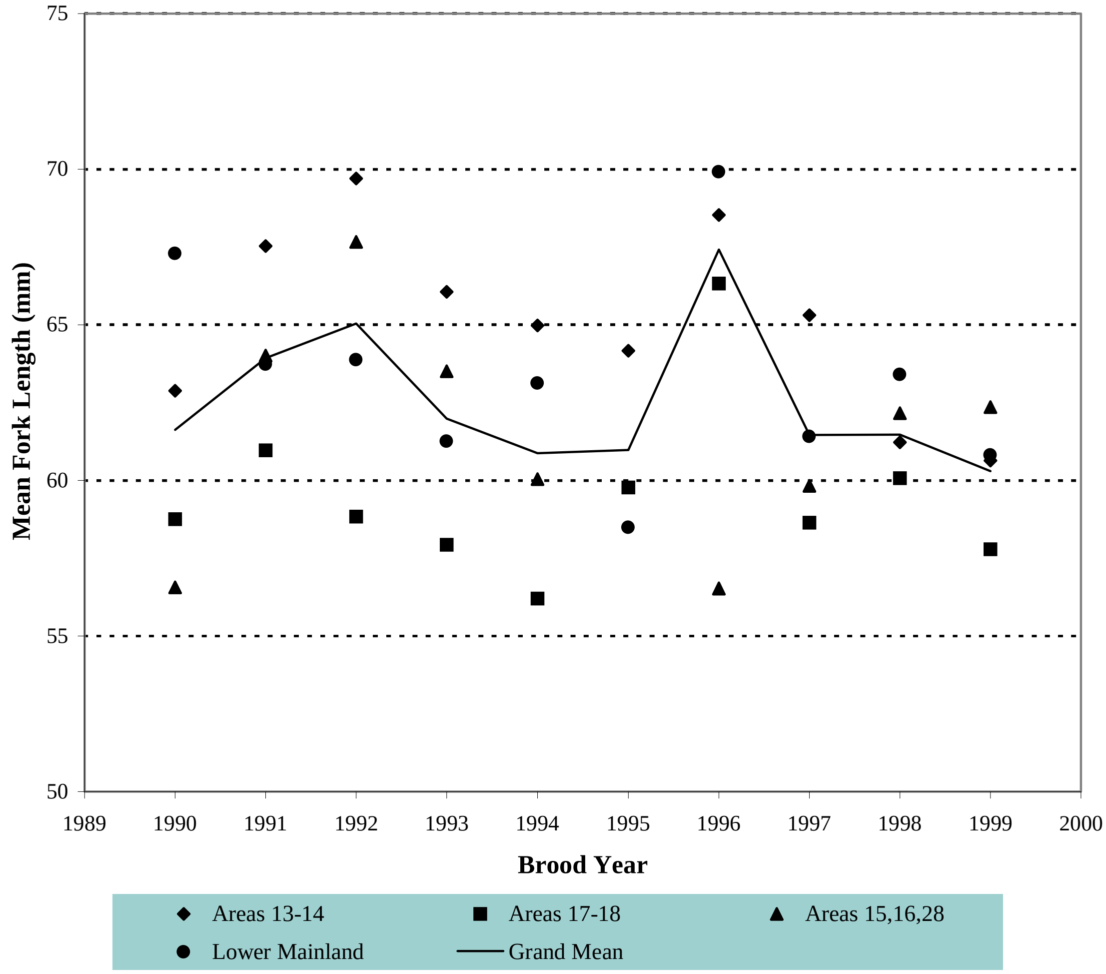

Figure 5. Mean fork length of coho fry in sub-areas of the Georgia Basin, 1990 to 1999 brood years. Points are mean sizes of age 0. fry in selected streams of each sub-area and the line is a plot of the annual mean size in all selected streams in the Basin. Streams with significant enhancement were excluded.

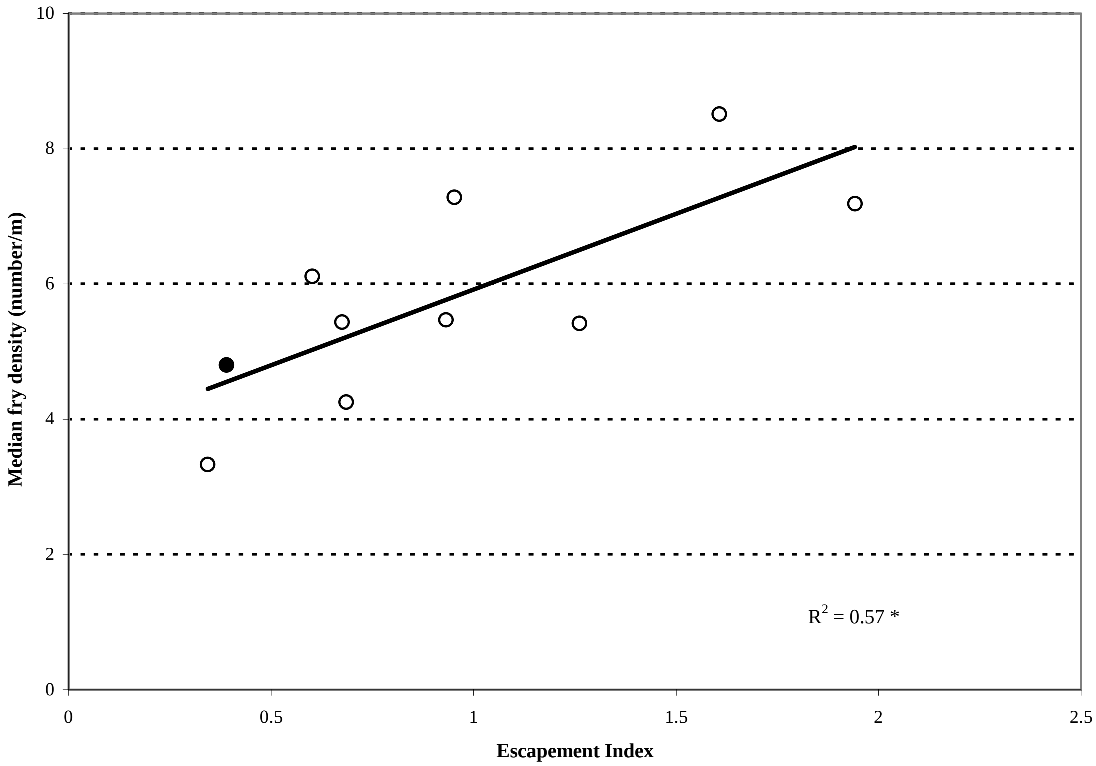

Figure 6. Density of coho fry related to parental escapements, 1990 to 1999 brood years. The escapement index uses escapements to Black, Cowichan and Salmon rivers and is explained in the text. The latest brood year, 1999, is shown as a black circle.

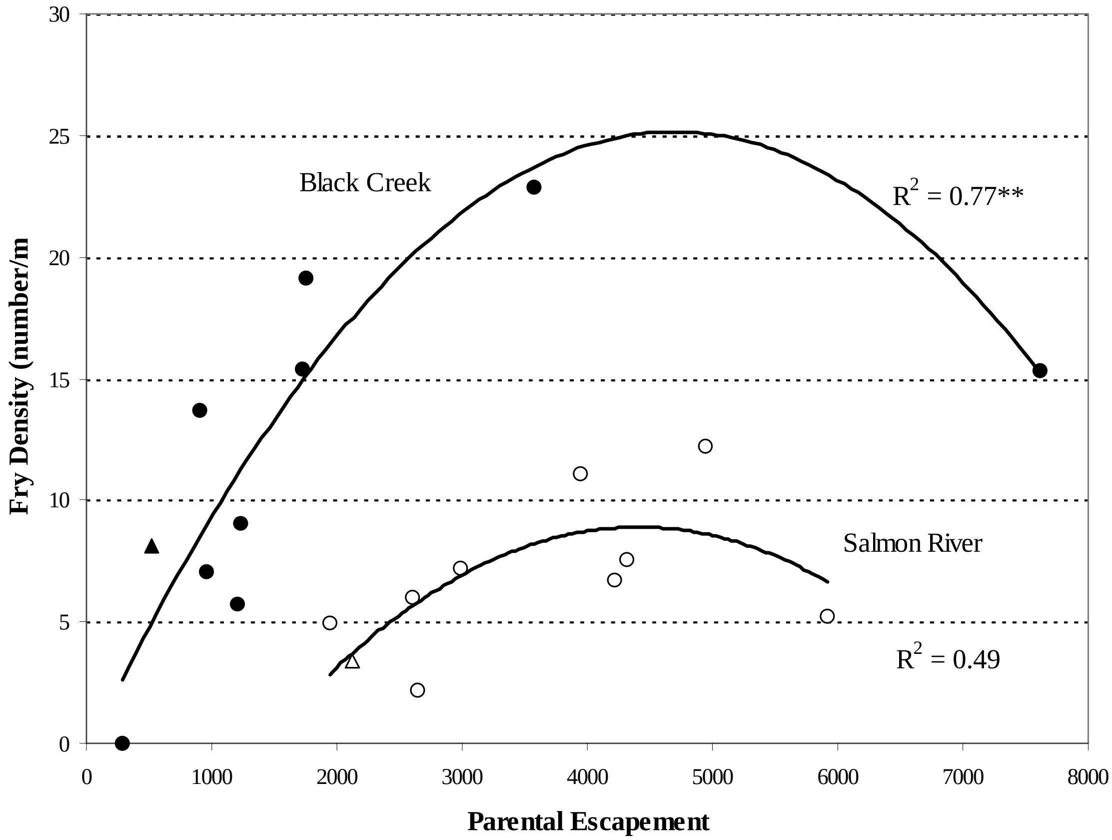

Figure 7. Density of coho fry at one site in Black Creek and one site in Salmon River related to the parental escapement to the streams, 1990 to 1999 brood years. The latest brood year, 1999, is shown as a triangle in each series.

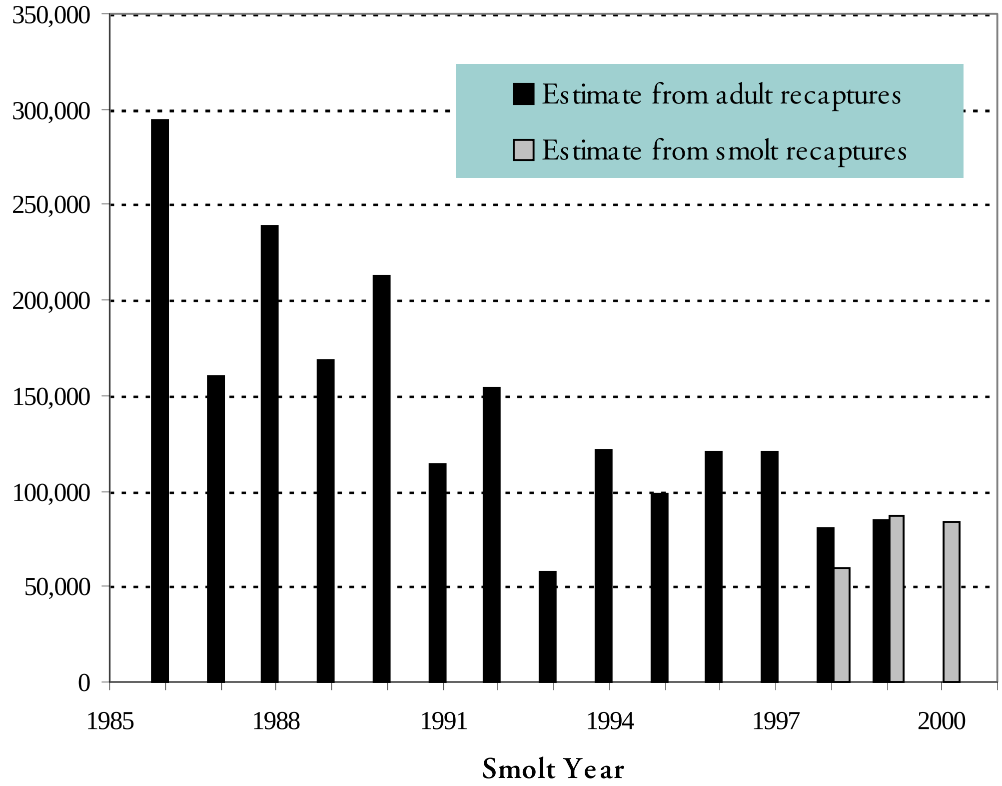

Figure 8. Coho smolt production from Salmon River (Langley). Salmon River abundances are derived as Petersen mark-recapture estimates using the number of marked adult recoveries the following year and since 1998 also using marked smolt recoveries during the smolt migration.

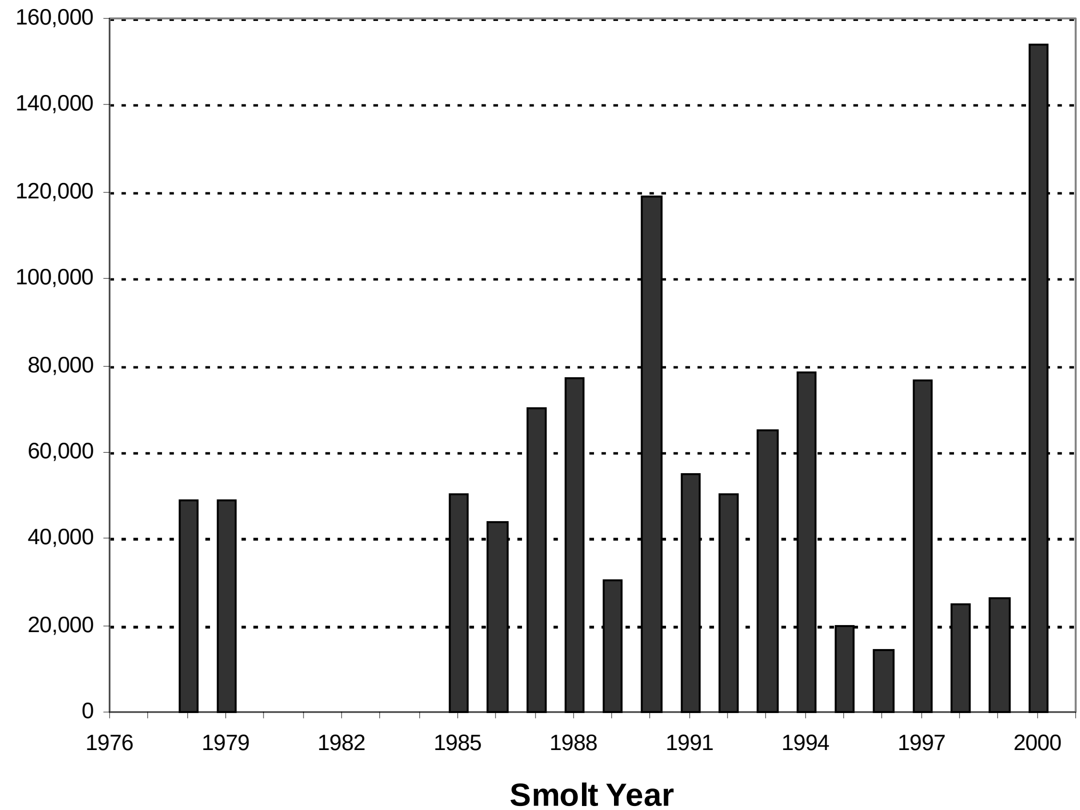

Figure 9. Coho smolt counts from Black Creek, 1978 to 2000. Counts include both age 1. and 2. smolts.

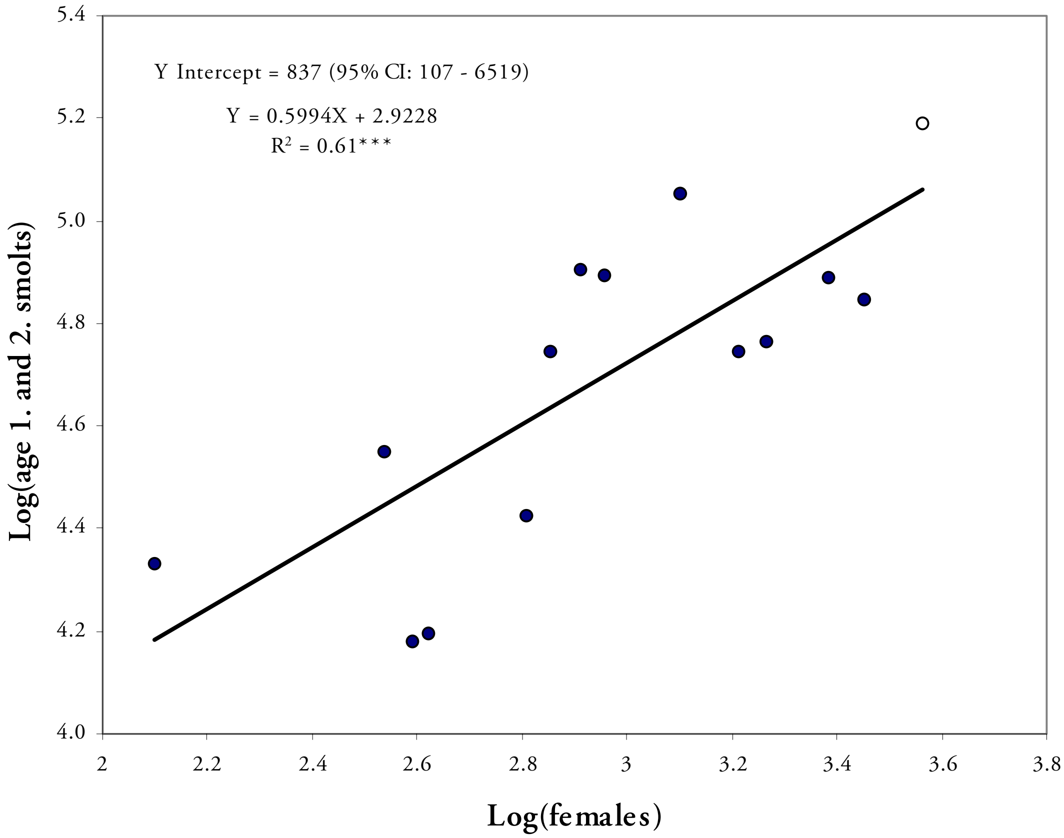

Figure 10. Log-log relationship between smolt abundance and parental female abundance of Black Creek coho, 1985 to 1998 brood years. The 1998 brood year point is shown as an open circle.

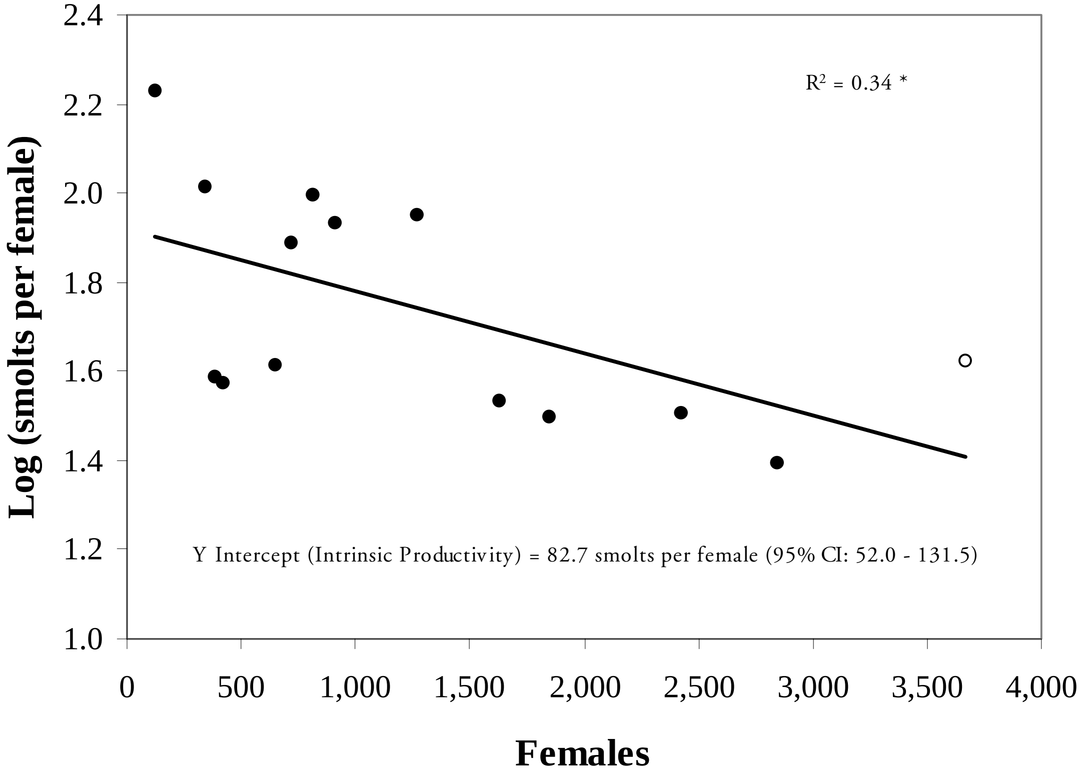

Figure 11. Smolts per female (log) versus parental female abundance of Black Creek coho, 1985 to 1998 brood years. The latest brood year, 1998, is shown as an open circle.

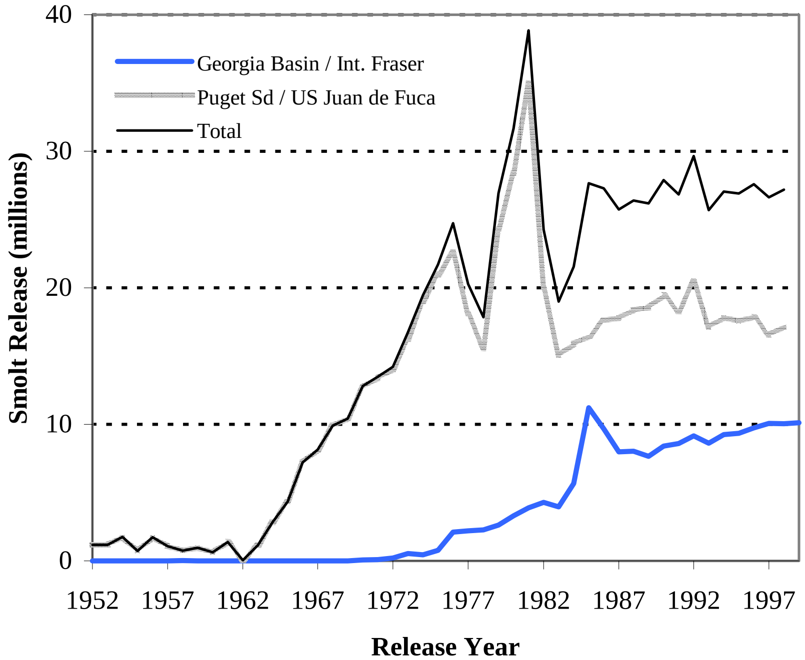

Figure 12. Total releases of 1952 – 1998 brood year smolts from Puget Sound / Juan de Fuca Strait hatcheries in Washington and Georgia Basin / Interior Fraser hatcheries in Canada. Johnstone Strait releases are included with Georgia Basin because almost all are from Quinsam Hatchery in Campbell River.

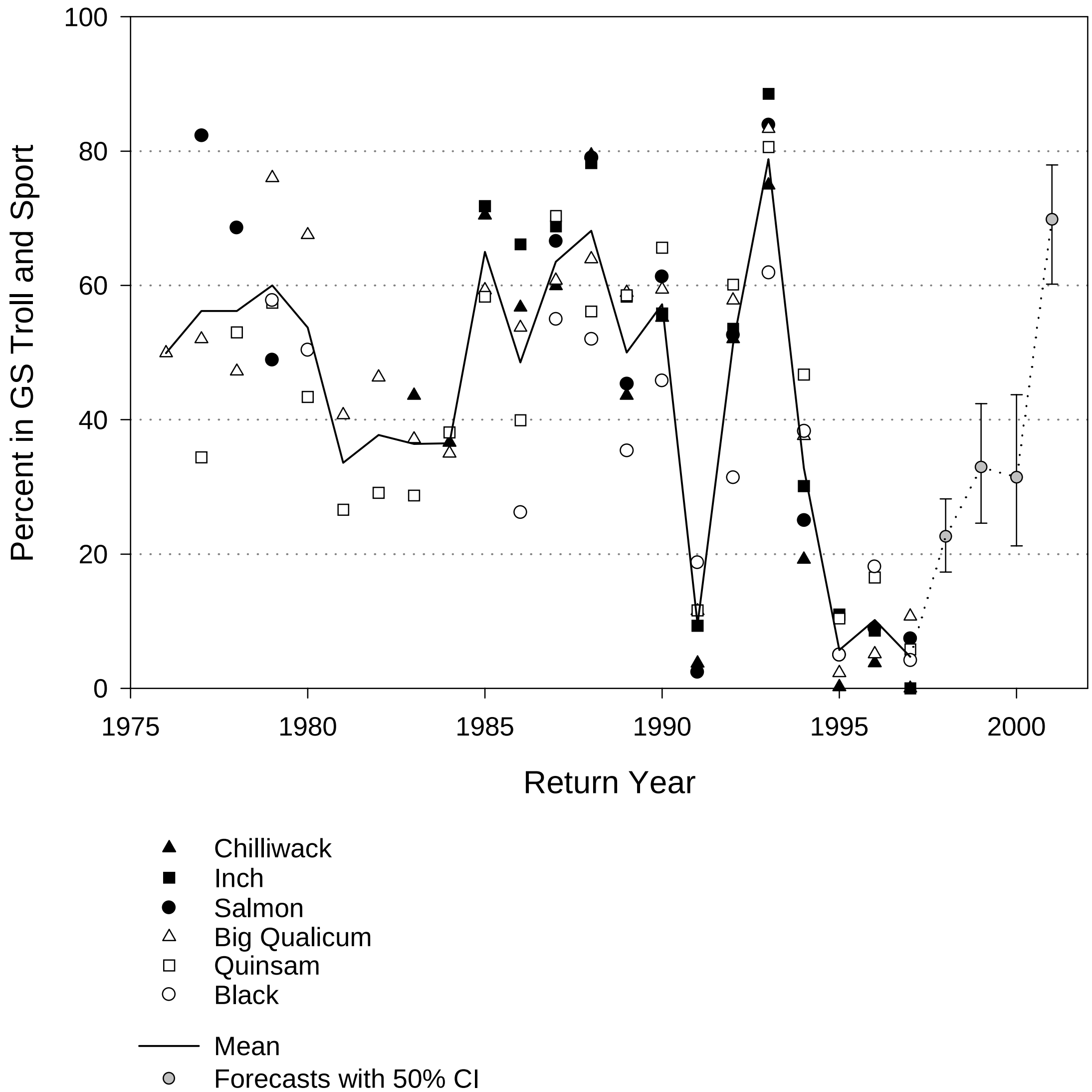

Figure 13. The proportion of total marine catch that came from the Strait of Georgia troll and sport fisheries, based on CWT recoveries from six coho indicator populations, 1976 to 2001. Washington State estimates are excluded. There were insufficient recoveries after 1997 and salinity-based forecasts of distribution are shown instead. Past performance of the forecast and observed coho encounters in the Strait support our belief that the forecasts were reasonably accurate.

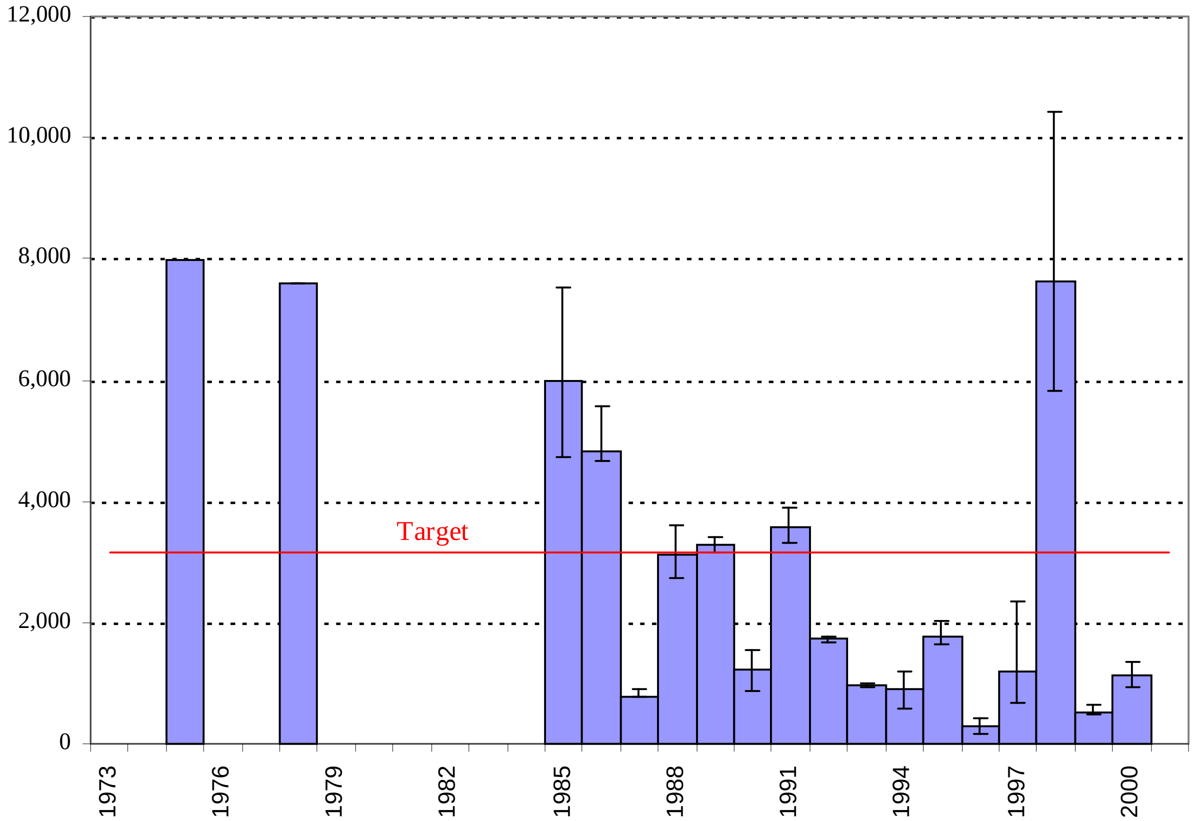

Figure 14. Mark-recapture estimates of escapement of adult coho to Black Creek, 1975 to 2000. The provisional escapement target is also shown, as are the 95% confidence intervals. There is no measure of uncertainty available for 1975 and there was a total fence count in 1978.

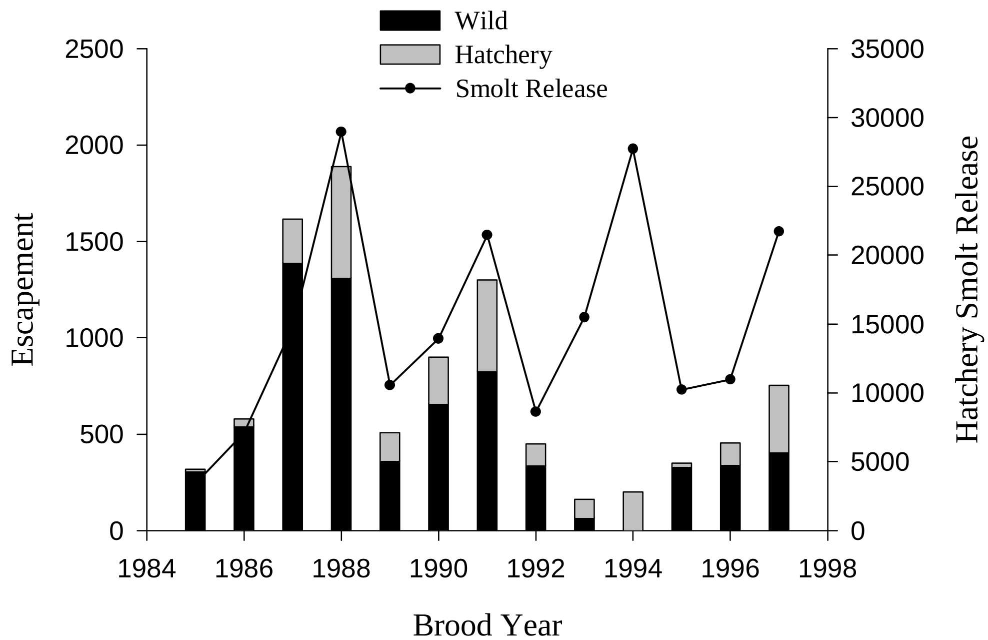

Figure 15. Estimated escapement of adult coho to Chase River in Nanaimo, 1985 to 1997 brood years. Smolt releases by the Malaspina University College Hatchery are also shown with estimates of their contribution to escapement.

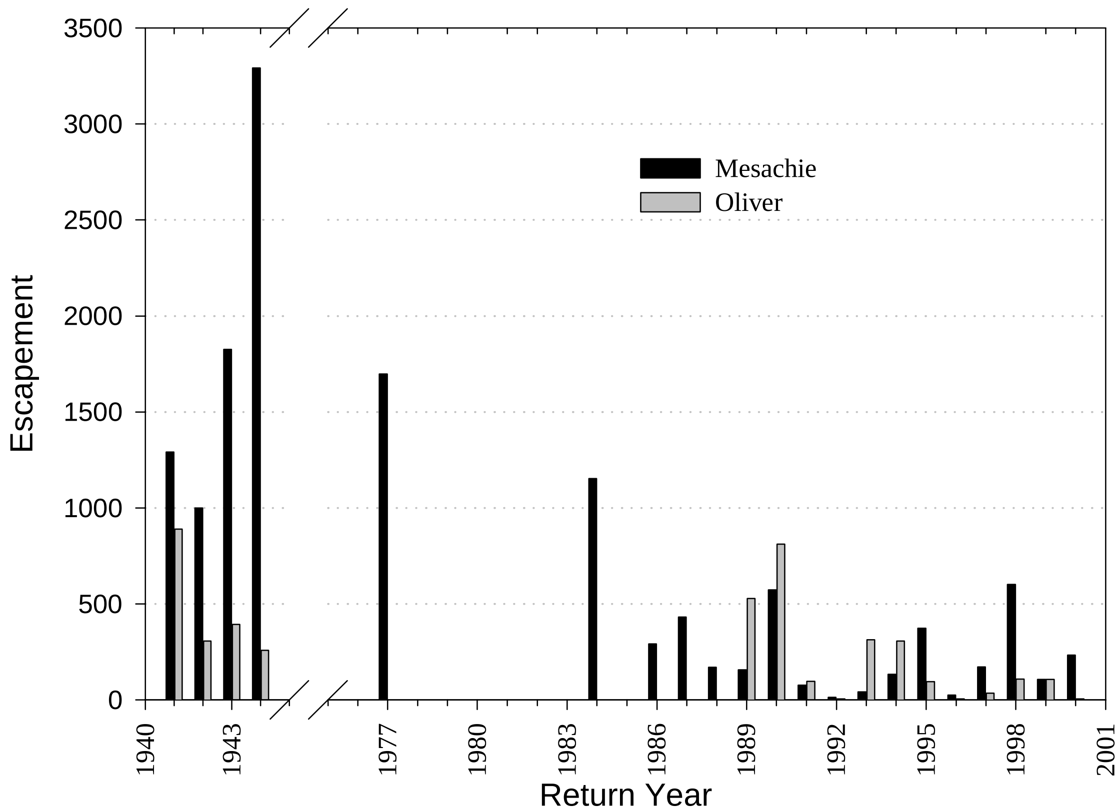

Figure 16. Estimated escapement of adult coho to Mesachie and Oliver creeks in the upper Cowichan River system, 1941 to 2000. Escapements to Oliver in 1992, 1996 and 2000 were 5, 5 and 6, respectively.

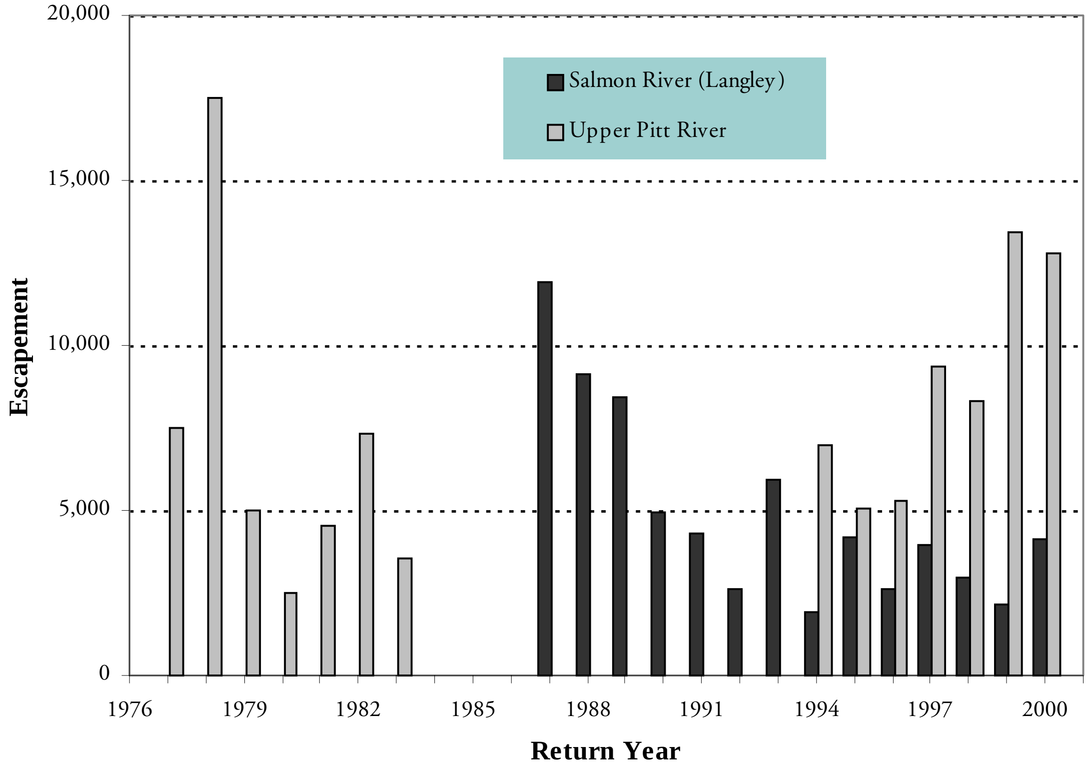

Figure 17. Estimated escapement of adult coho to Salmon and Upper Pitt rivers, 1977 to 2000.

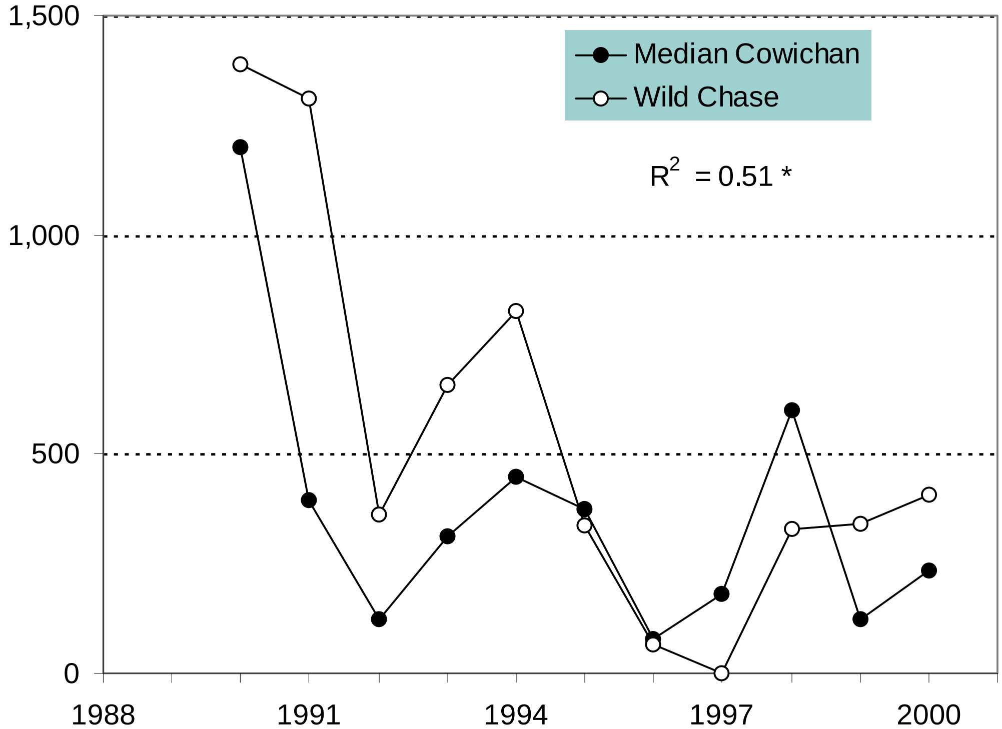

Figure 18. The median adult coho escapements for monitored Cowichan River tributaries, 1990 to 2000, with Chase River escapements for comparison. Chase escapements are estimates of the wild (naturally incubated) component.

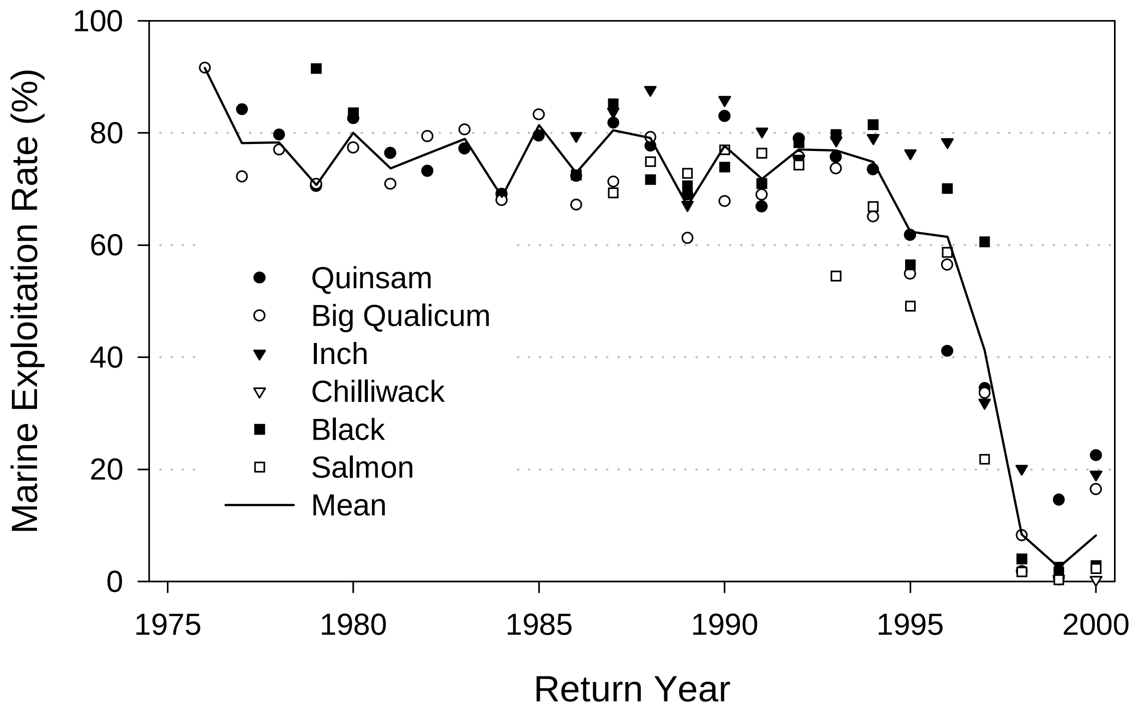

Figure 19. Marine exploitation rates of Georgia Basin hatchery and wild stocks, 1976-2000. Freshwater sport catches were treated as part of the escapement.

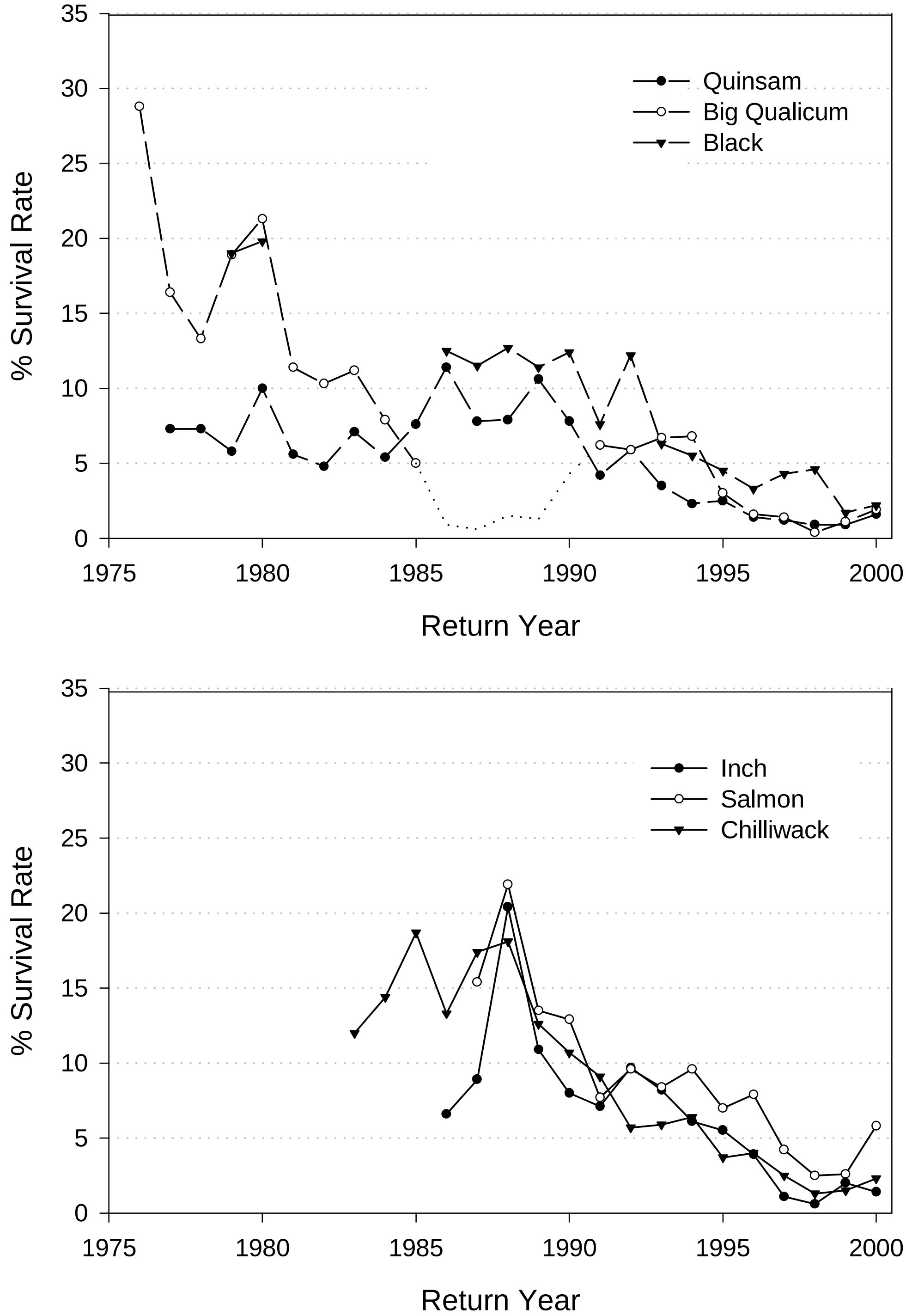

Figure 20. Coho smolt to adult survival rates of coastal Georgia Basin hatchery and wild indicator stocks, 1976-2000 return years. The top graph shows Vancouver Island indicator stocks and the bottom Lower Fraser stocks. The dashed line indicates a period from 1985-1990 when Big Qualicum hatchery was experiencing fish culture problems.