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Assessment of Coho Stocks on the West Coast of Vancouver Island, 1998

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Abstract

This working paper summarizes the abundance, exploitation rates and marine survival of coho stocks originating from streams on the west coast of Vancouver Island in 1998. Also included is a summary of the coho fry survey work that was completed in 1998. Returning adult coho salmon (‘escapement’) were either enumerated at counting weirs (e.g. Carnation Creek) or estimated from visual counts.

The two wild indicators, Carnation and Kirby Creek, had coho adult escapements of 272 and 323 respectively. At the Stamp Falls Fishway 70,711 adult coho were counted. Of these, 36,658 returned to Robertson Hatchery and the rest (34,053) were considered as the ‘wild’ return. The increases over the brood year for Carnation Creek and Stamp Falls Fishway counts are 55% and 385% respectively. Visual surveys were conducted in 57 rivers and tributaries this year. The results indicate a 370% increase from the brood year. Most streams showed dramatic increases in coho escapement during 1998; likely due to severe fishing restrictions imposed in 1998 and the possibility that smolt outputs may have been better in 1997 as well.

The exploitation rate for Robertson and Conuma Hatchery stocks was 1.9% (excluding freshwater fishery) and 1.2% respectively. The cessation of directed coho fishing has resulted in these rates dropping from recent years (they reached 75.5% in 1993). The marine survival for Robertson and Conuma Hatchery, and Carnation Creek stocks was 3.6%, 0.27%, and 5.6% respectively. The marine survival remained relatively poor compared to long term means. The Robertson Hatchery survival rate continues to slowly increase since the low survival year of 1994. The survival rate of Carnation Creek, the wild indicator, continues to fluctuate without a trend in the 5% - 10% range. The Conuma Hatchery survival rate reached the lowest level since 1986, and was lower than the 1994 return of 0.28%.

In 1998, 19 new fry survey sites were added in areas that have been under-represented in past years. Coho fry densities are trending upward in Area 24 and south, and stable in Area 25 and north.

Résumé

On résume dans le présent document, l'abondance, les taux d'exploitation et la survie en mer des stocks de saumons coho provenant des cours d'eau sur la côte ouest de l'Île de Vancouver en 1998. Vous trouverez également ci-joint un sommaire des relevés d'alevins de saumons coho terminés en 1998. Pour calculer le retour de saumons coho adultes (« remonte »), on a eu recours à des barrières de dénombrement (par exemple Carnation Creek) ou à des comptages visuels.

D'après les deux indicateurs de saumons sauvages à Carnation Creek et à Kirby Creek, la remonte de saumons coho adultes a été de 272 et de 323 respectivement. À la passe migratoire de Stamp Falls, on a dénombré 70 711 saumons coho adultes. De ce nombre, 36 658 saumons coho sont retournés à la pisciculture Robertson tandis que les autres (34 053 saumons coho) étaient considérés comme des « saumons sauvages » de retour. Les augmentations par rapport à l'année d'éclosion à Carnation Creek et à la passe migratoire de Stamp Falls sont de 55 % et de 385 % respectivement. On a effectué cette année des relevés visuels à 57 rivières et affluents. D'après les résultats, il y aurait eu une augmentation de 370 % par rapport à l'année d'éclosion. En 1998, il y a eu des augmentations majeures de la remonte de saumons coho dans la plupart des cours d'eau. Cette situation découle probablement des restrictions sévères imposées à pêche en 1998 et de la possibilité que les rendements de saumoneaux aient été meilleurs en 1997.

Le taux d'exploitation des stocks de la pisciculture Robertson et de la pisciculture Conuma a été de 1,9 % (ne comprend pas la pêche en eau douce) et de 1,2 % respectivement. Comme on a mis fin à la pêche sélective du saumon coho, ces taux ont chuté par rapport à ceux des années précédentes (le taux était de 75,5 % en 1993). Le taux de survie en mer des stocks provenant des piscicultures Robertson et Conuma et de Carnation Creek ont été de 3,6 %, 0,27 % et 5,6 % respectivement. Le taux de survie en mer est resté relativement faible si on le compare à la moyenne à long terme. Le taux de survie des stocks de la pisciculture Robertson continue d'augmenter lentement depuis 1994, année à laquelle il avait été le plus faible. L'indicateur de saumons sauvages à Carnation Creek montre que le taux de survie continue de fluctuer de 5 % à 10 % sans aucune tendance. Le taux de survie des stocks provenant de la pisciculture Conuma a atteint son niveau le plus faible depuis 1986. Il a été inférieur au retour de 1994 qui était de 0,28 %.

En 1998, on a effectué des relevés d'alevins à 19 nouveaux endroits dans des zones sous-représentées par le passé. Les densités d'alevins de saumons coho sont à la hausse dans la zone 24 et au sud de cette zone tandis qu'elles sont stables dans la zone 25 et au nord de cette zone.

1. Introduction

1998 was a year of continuing change for the management of coho salmon. Previous PSARC Working papers (Simpson and Baillie 1998; Kadowaki 1997; Simpson et al. 1997; Holtby and Kadowaki 1996; and Simpson et al. 1996) warned of a decrease in the abundance of coho in the Pacific Region to the point where some populations were in danger of extinction. Ocean survival of specific populations has dropped from 8% - 15% to 1% - 6% (Kadowaki 1997). There was concern for coho on the west coast of Vancouver Island (WCVI) because of below average ocean survivals of Robertson Hatchery coho and the deteriorating status of adjacent stocks in the Georgia Basin , Washington and Oregon.

In order to protect this species measures were adopted by fisheries managers that resulted in elimination of directed coho commercial fishing in the south coast in 1997. More restrictive daily catch and possession limits were imposed on WCVI and Juan de Fuca sport fisheries.

Ocean survival continued to be low and the restrictive measures adopted in 1997 needed to be expanded. The Coho Response Team was formed in early 1998 to study the problem and recommend solutions to protect the coho salmon while still offering an opportunity for commercial and sport fishermen to catch other salmon species. The result was no directed coho fisheries, and a target of zero fishing mortality of coho in other fisheries. Significant coho presence in catches would result in either relocation to another area or a fishery shut down. The sport fishery was non-retention of coho only in some areas and a complete ban in other areas.

This Working Paper assesses the 1998 status of coho salmon stocks on the west coast of Vancouver Island. It updates the previous PSARC Working Paper S98-7 (Simpson and Baillie 1998) which examined the state of coho stocks as of 1997. Forecasts of 1999 abundances were made in an another paper (S99-2, Holtby et al. 1999).

The PSARC Salmon Sub-committee recommended on the basis of S98-7 that:

> " … the impacts of hatchery mark selective fisheries on WCVI assessment programs (current and proposed) be evaluated."

This type of analysis is broad in scope and requires extensive resources to evaluate. It was not acted upon.

In S98-7 the authors noted that:

- There are an inadequate number of complete estimates of wild coho escapement for this region, and
- Areas 24 and 26 are particularly inaccessible to road based (juvenile coho fry) surveys.

Because of these shortfalls in data, a number of new projects were initiated in 1998:

- Adult spawner enumerations that have been ongoing since 1995 were extended further into the winter to obtain complete counts of coho salmon. New weekly counts were established in Areas 20, 21/22, 26 and 27.
- In-river coho spawners were surveyed in Conuma River to obtain a complete CWT escapement estimate so that survival and exploitation estimates can be calculated.
- Coho fry surveys were expanded to include systems in areas 24 – 26 that are boat access only.

2. Description of Stocks

The number and size distribution of coho stocks was discussed by Simpson et al. (1996). Up to 1994, coho had been reported at least once in DFO annual escapement reports in 223 streams. They are estimated to occur in about 700 streams with Areas 24, 25 and 27 having more than other Areas. Average escapement estimates to half the reported streams from 1970 to 1994 were less than 85 spawners, 75% had estimates of less than 255. Only two river systems averaged over 5,000 spawners, San Juan and Somass. The 25 year (1974-98) average escapement to San Juan is 8015 and the 1974-98 average for Somass is 34,524. Both have hatchery enhancement, especially Somass (Robertson Creek Hatchery).

Most WCVI coho, as represented by CWT recoveries from releases by the three major hatcheries, are usually not caught in coastal waters outside of the WCVI region (Simpson et al. 1996). Between 1989 and 1995, 91% of Robertson and Nitinat coho recoveries and almost 99% of Conuma recoveries were in the SWVI and NWVI catch regions. There was no evidence of a shift from SWVI to NWVI in the warm water El Nino events of 1992 and 1993.

3. Description of Fisheries

In order to protect depressed coho stocks from the upper Skeena and Thompson River (Fraser) the region was divided into Yellow and Red zones.

Yellow zones were areas where these endangered stocks are not prevalent. These areas were the Alberni Canal part of Area 23 and Areas 24 through 27 for the entire year, and Victoria to Barkley Sound (Areas 20 to 23) and Areas 123 to 127 from October to May. Red zones were areas in which Thompson River coho were prevalent. The Red zones were Victoria to Barkley Sound (Areas 20 to 23) and Areas 123 to 127 from June to September.

3.1. Commercial

Prior to 1998, the WCVI troll fishery was the single largest harvester of coho salmon in British Columbia. The troll catch from 1985 to 1994 averaged 1.65 million, with several hundred vessels participating. The fishery has been managed to a catch ceiling under the Canada/US Pacific Salmon Treaty since 1985: 1.75 M in 1985 and 1986; 1.8 M from 1987 to 1992; 1.7 M in 1993; 1.2 M in 1995 and 1.0 M in 1996 (there was no ceiling in 1994). After building up to the mid-1980’s, catches in the WCVI troll fishery began to decline through the 1990’s (Table 1, Figure 1). Catches reflected the catch allocations until 1996 when the fleet was not able to achieve its allocation of 1 million coho. The catch of WCVI coho in commercial net fisheries is limited to incidental catches, largely in the sockeye fishery in Area 23 and fisheries for chum and chinook returning to Nitinat, Robertson and Conuma hatcheries.

During 1998 there were no directed commercial fisheries on coho salmon. Commercial fisheries on other salmon species were restricted to the Yellow zones where stocks of concern (Thompson River and Upper Skeena) are not prevalent. These fisheries were required to release any live coho that were caught during operations. There were no salmon fisheries in Red zones.

3.2. Sport

Recreational fishers were not allowed to retain coho in 1998. In Yellow zones fishing was permitted for other species with length and limit restrictions. In Red zones recreational fishing was not allowed, except for inshore areas as described by the fishing regulations, again with length and limit restrictions

One exception to the non-retention of coho was the Stamp River. A large return of coho, (monitored at the Stamp Falls fishway), enabled a sport fishery to target coho in the non-tidal portion of the Stamp River. The fishery occurred from September 9 to October 5 below Stamp Falls and from September 9 to November 15 from Stamp Falls to Summer Creek (some boundary restrictions were put in place within these areas). A retention of 2 coho/day was permitted from September 9 to October 5 and 4 coho/day from October 6 to November 15. Non-retention applied to catches below the Stamp/Sproat confluence for all periods. The fishery was monitored by creel survey. The survey (conducted by J. O. Thomas & Assoc.) had two components. Roving surveyors operated on foot and by drift boat and monitored effort. They also interviewed anglers for CPUE. Static surveyors observed anglers at certain access points to the river. They obtained effort and CPUE data from these locations. This ensured that no bias was introduced because the ‘roving’ observers were obtaining interviews from ‘partial’ angler days. The ‘static’ observers also interviewed fishers at the end of their shift.

A preliminary estimate of catch and effort (Doug Tallman, J. O. Thomas and Associates, pers. comm.) shows a harvest of 1000 coho and a release of 1500 coho for 15000 hours of angler effort. Catch was highly variable with very good catches (many 10+ fish days) obtained below Stamp Falls in late September and early October.

4. Methods

4.1. Counting Facilities

4.1.1. Carnation Creek

Carnation Creek is a small (~10 km^2 watershed) stream on the south side of Barkley Sound in Area 23. There is 3.1 km of accessible stream. In 1971 a joint project was initiated to study the effects of forestry practices on a coastal salmon-bearing system. As part of this study a fish counting weir was constructed at the upper tidal influence. Counts of adult salmon (coho and chum) returning to spawn and juvenile fry and smolts are conducted annually. This time series of 29 years of fry, smolt, and adult counts represents the best data set of coho on the west coast of Vancouver Island and is the only wild coho indicator stock. For more details concerning the Carnation Creek Project see Hartman and Scrivener, 1990.

The counting weir is a rigid structure that is used for counting both upstream migrating adults and downstream migrating juveniles. The adult weir phase is set up during the low flow period in August and is operated through November when adult salmon have ceased to move through the weir. Adults were blocked from moving past the weir and directed into a holding box where they were caught with nets, sampled and released upstream. Species, sex, fork length, weight, as well as any external marks are noted. A scale sample is taken for age analysis.

The juvenile weir phase is set up during March, before the fry emerge from the gravel. Juvenile salmon are funnelled into a set of five boxes by perforated 'fan traps'. These boxes are cleared out daily and the trapped animals are sampled and released downstream. Species, fork length, weight are noted and a scale sample is taken for age analysis.

Coho and chum salmon are annual spawners, and chinook, sockeye, and pink have occurred sporadically. Cutthroat and rainbow trout are also found here.

4.1.2. Kirby Creek

Kirby Creek is a small stream located on the southwest corner of Vancouver Island (Area 20) and drains into the Strait of Juan de Fuca approximately 12.5 kms west of Sooke. The mainstem has 6.4 kms of accessible reach, and a main tributary enters the system 1.2 km upstream with 1.1 kms of accessible reach. Coho and chum salmon, as well as steelhead trout, are anadromous migrants to this system. Resident cutthroat trout are present as well. Operations started in the fall of 1997.

The counting weir is 800m upstream from the estuary and is about 400m above tidal influence. A floating style fence is used to block passage of adult salmon, diverting them into a trap. The salmon are netted out and sampled for species, sex, fork length, weight and a scale sample is taken for age analysis. The animal is then tagged with an external marker and released upstream. In 1998 the weir was installed in mid-September, before the fall storms increased the water level, and operated until December 30.

Visual counts are conducted regularly to provide a backup estimate if the counting weir is unable to operate. Carcasses with tags are noted so that a survey life can be estimated using the difference between the day the tag was applied and the day it was collected, adjusting for the condition of the carcass.

The counting weir structure that is used for juveniles is a rigid "A" frame structure. Screened frames are slid into "I" beams and block the passage of juvenile salmon. A solid plywood panel is used in one section, with a flexible pipe leading downstream to a holding box. Juveniles are removed and sampled for species, fork length, weight and a scale sample is taken. In 1999, the coho smolts are being coded-wire tagged for exploitation and marine survival analysis. Prior to Spring operations, a mark-recapture project is conducted below the weir site in the lower 800 m to establish the number of coho smolts that will not be enumerated by the weir. The animals caught are also being injected with a coded-wire tag (CWT) this year.

The Kirby Creek Project is a study operated by the Community Fisheries Development Centre - South Island Streams and funded by World Fisheries Trust and DFO.

4.1.3. Stamp Falls

Stamp River drains Great Central Lake and joins Sproat River to form the Somass River, which flows into the head of Alberni Inlet. There is a fishway at Stamp Falls through which sockeye, chinook and coho are counted as they pass. Robertson Hatchery is above the fishway but hatchery coho cannot be distinguished in the count. A rough estimate of the number of natural spawners is simply the difference between the coho escapement into Robertson Hatchery and the fishway count. Accurate detection of wild trends therefore requires that a high proportion of Robertson coho enter the hatchery and do not spawn elsewhere. This is not true for chinook but there are unconfirmed reports from early work that few hatchery coho are found elsewhere (Simpson et al. 1996). Work is currently under way to assess this by determining the percentage of coho with adipose clips at Stamp Falls.

Two different methods have been used to estimate salmonid migration through Stamp Falls since 1990. From 1990 to 1995 migrants were counted visually (using tally counters for each species) as they passed over a flashboard on the base of the fishway. Verification of species accuracy and counts were conducted by trapping fish for approximately one hour each day at varying times and conditions and for different observers. Trapped fish were dipnetted out of the trap and carefully checked for species. Hourly visual counts and species identification were adjusted in proportion to the difference between the observed visual counts and the true verified counts. During these years, the fishway was closed at night and adjustments were made to counts during periods when counting was not possible.

From 1996 to 1998 migration has been monitored with the use of underwater video cameras. The setup of the camera, lighting and video equipment has been modified and improved each year. During 1996 and 1997 the fishway was left open at night. Migration during these night time periods is unknown. The procedures used in 1998 are as follows.

Salmon were monitored through Stamp Falls fishway from September 2 until November 10, 1998. A snorkel survey conducted above Stamp Falls on September 2 estimated the number of salmonids already in the system above the counting facility at Stamp Falls.

Observations at Stamp Falls fishway counting facility were conducted for about 14 hours per day from September 2 to 17, from approximately 0.5 hour before sunrise to 0.5 hour after sunset. From September 18 to October 25, observations took place for 24 hours/day, as part of the Barkley Sound Selective Fishery Program, which required enumeration of spaghetti tagged salmon at the fishway. From October 26 to November 10 observation was reduced to 12 hours/day and the fishway was closed to migration at night. Early in the season, before 24-hour counting, a mechanical counter was installed to determine night time migration. This showed limited fish movement but was difficult to quantify in terms of both species and numbers. Daytime migration during this period was primarily sockeye and coho but with some chinook. Night time migrants were therefore also assumed to be sockeye and coho with a few chinook. Later in September and early October, during the 24-hour observations, up to 35% of all coho observed during any 24-hour period were migrating at night. However, this night time migration may not be indicative of natural night time migration. Artificial lights used in the fishway and/or high densities of fish in the fishway may have had an impact. It was noted that once the coho moved into the illuminated area of the fishway they were reluctant to exit into the darkened river. A buildup of fish occurred at the exit of the fishway during daylight hours but not to the same extent as that observed at night. Even if up to 35% of all coho were migrating at night during this period it would only increase coho escapement by about 800 fish.

A counting tunnel/observation box was installed in the fishway and was raised/lowered on a worm gear as the river level fluctuated. A series of screens ensured the fish must swim through the counting tunnel. A video camera was mounted vertically above the counting tunnel and above the water. A mirror was placed beneath the camera and at a 45° angle behind a sheet of Plexiglas that divided the observation box lengthwise. This enabled the fish to be observed from above in half the image and a reflection of the side of the fish in the other half. The viewing box and camera were covered with heavy black plastic to eliminate the reflection of light from above. Underwater lights were placed in the box to provide light for the camera and observers. A number of different lighting setups were tried before a satisfactory one was found.

Observations were conducted in real time through a 21inch high-resolution colour monitor. A Super VHS time lapse VCR simultaneously recorded the migration. Observations were entered into a customized MSAccess program on a laptop PC. Time, date, observer, species, direction of migration, maturity (adult or jack) and adipose clip data was recorded for each fish as it passed by, along with any comments. Jack coho were determined by their much smaller size from the adults and by using reference markings of known size on the base and back of the tunnel. The time lapse VCR provided excellent image quality and left a time/date stamp on the image. Synchronized times between the VCR and the Stamp Falls database enabled comparison of the 'real time' observations entered into the database with subsequent verifications.

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

Linear regression was used to compare the verification with the 'real time' observations. Results indicated that the best predictor for adult coho was, as expected, adult coho and for jacks was jack coho.

The total observed counts at Stamp Falls were corrected using the following relationships between adjusted (COADadj or COJKadj) and real time (RT) counts:

Coho adults: $COADadj = RT \times 1.044 - (4.125)$ Equation 1

$(r^2=0.961, \quad d.f. = 93)$

Coho jacks: $COJKadj = RT \times 0.796 - (0.353)$ Equation 2

$(r^2=0.711, \quad d.f. = 93)$

Where: COADadj = adjusted coho adult count

COJKadj = adjusted coho jack count

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

4.2. Catch

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

In 1998,because of serious conservation concerns for threatened wild coho stocks particularly those originating from the upper Skeena and Thompson rivers, special monitoring programs were implemented in all fisheries to ensure compliance with coho non-retention and non-possession regulations. The aim was to achieve zero fishing mortality for coho stocks from the upper Skeena and Thompson rivers (in red zones where these stocks are prevalent) and minimal risk of by-catch mortality for all other coho (in yellow zones where upper Skeena and Thompson coho stocks are not prevalent). The monitoring programs tracked and verified the reliability of coho encounter rates obtained by creel surveys in the Strait of Georgia and some west coast Vancouver Island recreational fisheries. There were on-board and roving observers from the end of July through September in the Strait and volunteer observers made direct observations on board sport charter vessels on the West Coast from about mid-July through mid-October. Moreover, catch monitoring of all southern BC commercial fisheries was initiated and consisted of on-board observers and mandatory provision of hail data. The overall goal of these programs was to avoid coho by-catch and reduce the mortality associated with catch and release, when coho were encountered. These estimates of the number of coho encountered in the various south coast fisheries was summarised by Bill Shaw, South Coast Division. Included in the summaries are estimates of coho mortalities, assuming release mortalities specific to each gear type (net, troll and sport angling).

4.3. Exploitation and Marine Survival

The necessary estimates of both catch and escapement for calculating exploitation and survival rates have only been available for the Robertson Creek hatchery population in the WCVI region. While the other two major hatcheries release CWT'd coho smolts, the number of returning adults is unknown. However their CWT releases are valuable indicators of ocean distribution and survival to the fishery.

CWT recoveries were obtained from the SSA - MRP database in the PBS VAX computer. Expanded recoveries from both commercial and sport fishing from both the United States and Canada were used. Expanded recoveries are the observed recoveries multiplied by the catch: sample ratio in the fishery and divided by the tagged proportion of the total hatchery release. Recoveries by catch region were not filtered to exclude strata with few recoveries where the sampling rate was low (causing a large number of recoveries to be estimated from a few recoveries with correspondingly large confidence limits on the estimate). Only CWT codes that have been approved for exploitation and marine survival analysis were used. These are groups that have been released through the normal hatchery process. For example, groups that were used for experimental treatments or were released off-site were not included in the analysis.

The Robertson Hatchery exploitation was calculated two ways. The catch used to calculate the total (type 'A") exploitation included the sport catch in the Somass system. Marine or type 'B" exploitation was calculated by including the freshwater sport catch as part of the escapement, the rationale being that wild stocks are not subject to freshwater fisheries like this.

This year the wild coho escapement in the Conuma River was surveyed to estimate the number of CWT'd coho that did not return directly to the hatchery. This provided an escapement figure for hatchery production from which the exploitation rate could be calculated.

The wild smolt production from Carnation Creek is enumerated but not CWT'd. In order to estimate the catch from this system the known escapement and the marine Robertson exploitation rate was used in the formula:

$$\text{Carn. Catch} = \frac{(\text{Rob. Exploitation} * \text{Carn. Escapement})}{(1 - \text{Rob. Exploitation})} \qquad \text{Equation 3}$$

4.4. Escapement Enumeration

In 1998, there was a substantial increase in effort to obtain complete counts of wild coho escapement in this region. In addition to counts of coho at fish counting weirs at Kirby Creek and Carnation Creek and the fishway counts from Stamp Fall in the Somass system, the WCVI Wild Chinook Enumeration Project (W. Luedke and B. Patten) extended their survey period to include more coho enumerations. As well, 2 systems in Area 20, 2 systems and 2 tributaries in Area 21/22, 7 systems in Area 26, and 7 systems in Area 27 were added. The Ministry of Environment, Lands and Parks (MOELP) continued their 21 year record of swim counts of summer coho in Gold River. As noted above, Robertson Hatchery is the only enhancement facility with a time series of accurate escapement estimates.

The data provided by the chinook enumeration project are the best extensive data we have from Areas other than 23. Coho were counted and escapement estimates were obtained in 47 streams and tributaries in 1998. Crews swam sections of rivers known to have chinook spawners and recorded jack and adult sightings of all species. Most of the counts during 1995 to 1997 were in lower mainstems and coho were often known to spawn out of the reach in the middle and upper mainstem and tributaries. However, swims were often weekly and usually began before coho entry so transitory coho may have been counted. Also, it is not unusual for coho to hold in the lower reaches before proceeding into smaller waters to spawn. The hope is that these counts may be indicative of at least annual trends. During 1998, increased emphasis on coho resulted in extension of snorkel survey coverage into upper mainstems. Also, surveys were conducted during December and January in some systems in order to survey a greater proportion of the coho migration period. Area-Under-the-Curve estimates were made for each year based on each series of counts assuming a residence time (survey life) and observer efficiency (e.g. English et al. 1992).

Observer efficiency figures were derived from the observers own estimates of their efficiency. Estimates of less than 50% were excluded from AUC calculations. Residence time figures were based on observer comments regarding fish condition from week to week, and comparing peak live counts and peak mortality counts.

4.5. Juvenile Coho Surveys

Juvenile coho survey methodology and rationale is described in Simpson and Baillie, 1998. To summarize, the juvenile coho surveys are used to supplement the data obtained from indicator stocks. They allow us to gain a wider perspective of the status of coho stocks within the region with a relatively inexpensive method. The data collected allow us to calculate the fry density for a given reach with respect to length, total wetted area and ‘pool’ area (water deeper than 10 cm), and fork length statistics including mean, kurtosis and skewness of the length frequency distribution.

It should be noted that sites were not selected randomly: accessible reaches were selected that were judged to be coho habitat (lower gradient areas with pool and cover habitat were favoured). Although the fry survey methodology is under review and some form of stratified random design may be deemed necessary for new analysis requirements, random selection was not considered necessary for the first purpose of the data which was 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.

In 1998, sampling continued as in 1997, and 19 new sites were added in Area 24 (9), Area 25 (5), and Area 26 (5). These sites are only accessible by boat and are from areas that are underrepresented in previous years.

5. Results

5.1. Counting Facilities

5.1.1. Carnation Creek

In the previous 28 years the number of adult spawners that have returned to Carnation Creek has ranged from a high of 312 in 1979 to a low of 9 in 1994, with an average of 129. In 1998, 130 adult male coho, 142 adult female coho and 81 ‘jack’ male coho were counted through the Carnation Creek weir. This figure of 272 adults is the second highest on record and is 55% higher than the 1995 brood year (Figure 2).

5.1.2. Kirby Creek

In Simpson and Baillie (1998), the 1997 escapement to Kirby Creek was reported as 300 coho. The weir was not in operation when the first fall storms arrived, allowing passage of an unknown number of coho. The estimate was derived using a Peterson mark-recapture method, but with only 4 marks recovered the estimate was likely to be inaccurate. The visual counts from above the fence were re-examined and analysed and an AUC estimate of 146 was calculated. This estimate is considered to be a more appropriate estimate of the number of spawners above the fence. It was based on a survey life of 13.5 d for coho that have passed the fence. The survey life was estimated using carcass recoveries of coho tagged at the fence in 1997 and 1998. We do not have a good estimate of the number of coho that spawned in the 800 m below the fence because of the difficulty in knowing how many of the coho that were counted below the fence eventually migrated upstream past the fence. We do not think that the proportion spawning below the fence is large but the Kirby Creek estimates in 1997 and 1998 do not include this portion of the stream population.

In 1998, the AUC estimate of the above-fence escapement was 323 adult coho. After operations commenced in October, a series of storms raised the water level and fence operations could not continue. With only two years of results, our conclusions are limited to the observation that the 1998 escapement was probably at least twice as large as in 1997.

5.1.3. Stamp Falls

Low flows and high water temperatures in the Stamp River resulted in unusual run timings for salmonids during 1998. A large and very late component of the Great Central Lake sockeye run combined with the largest recorded return of coho resulted in high densities at the entrance to and within the fishway from mid September until mid October. The main component of coho migration took place through Stamp Falls from September 20 until October 19 and continued into early November.

‘Wild’ escapements past Stamp Falls increased by a factor of 10 from the critical 1997 levels (Table 2). This dramatic increase produced the largest ‘wild’ or ‘in-river’ escapement ever recorded for this system. As will be seen in the next section, the improvement in the total coho count past Stamp Falls is a result of the very low exploitation rates on Stamp River coho stocks (Figure 3) as a result of the moratorium on coho fisheries and incidental retention. Some improvement can also be associated with the gradual increase in survival rates since 1994 (Figure 4). Note that ‘wild’ escapements are strongly correlated with Robertson escapements (Figure 5). This suggests that either:

- ocean survival and exploitation variations have been driving escapement variations more than freshwater survival

  or

- most ‘in-river’ spawners are not wild but are of hatchery origin.

Preliminary work, including observation of adipose clipped coho during the Stamp River chinook deadpitch suggest that some of the ‘in-river’ spawners are of hatchery origin. Further work studying the mark rates of coho at Stamp Falls and Robertson Creek Hatchery is required to accurately determine the hatchery and wild components of in-river spawners.

5.2. Catch

Although there was no directed fishery on coho in 1998, coho were caught in other directed, test, and experimental fisheries. Live coho that were present in the catch were released.

Table 3 is the WCVI summary of the Total Unallowable Mortalities (TUM) In-season Final Report (unpubl. data, Bill Shaw, DFO, 3225 Stephenson Point Rd., Nanaimo). It shows the incidence of coho encounters in the various fisheries that took place along the west coast of Vancouver Island. Note that although these fisheries took place on the west coast of Vancouver Island many of these coho will originate from areas other than WCVI. As the summary at the bottom shows, out of the 85,514 encounters there were estimated 11,654 mortalities (13.6%).

5.3. Exploitation and Marine Survival

In 1998, the total and marine exploitation rates for the Robertson Hatchery CWT releases was calculated to be 2.2% and 1.9%, respectively (Table 4A). This table shows a figure of 87 coho that were caught in the sport fishery along the west coast of Vancouver Island (WSPT). This is the expanded estimate from one CWT’d coho that was caught near Tzartus Island in Barkley Sound and was recorded from a creel survey. Although the confidence limits around the exploitation estimates are obviously very large and they do not include the major fishing mortality which was release mortality, clearly the true exploitation rate is a far cry from several years ago when the west coast troll fleet would catch over two million coho annually, resulting in exploitation rates of over 70% (Table 2, Table 4A, Figure 1). The actual exploitation rate is unlikely to have been greater than 5% in 1998.

The marine survival of Robertson coho was calculated to be 3.6% for the 1998 return. This rate has continued to slowly increase since the disastrous return of 1994.

There were 159 carcasses examined during the deadpitch surveys on the Conuma River. Of these, 6 had adipose clips indicating they were CWT’d at the hatchery. The AUC estimate for coho escapement to the Conuma River was 1,645 or 10.35 times the carcass recovery. Expanding the six ad-clipped fish by this multiplier gives an estimate of 62 ad-clipped coho that spawned naturally. 33 ad-clipped coho adults returned back to the hatchery. The CWT expansion factor based on the proportion of the smolt production that was ad-clipped was 2.662, resulting in an estimated escapement of 253 hatchery coho (165 natural spawners and 88 returning to the hatchery). The MRP database reported 3 coho were caught in all fisheries (Table 4B). From this information the exploitation rate for Conuma Hatchery was calculated to be 1.2%.

In the spring of 1997, a total of 95,638 coho smolts were released. The marine survival was calculated to be 0.27%, which is lower than the previous year which was already very low (0.62%). This poor marine survival may be indicating a local phenomenon. Figure 6, which shows escapement trends for WCVI, shows monitored escapements in Area 25 did not increase as much as the rest of the region in 1998.

Prior to 1998, the return was calculated from the catch of Conuma CWTs and assuming a rough estimate of escapement based on using the Robertson exploitation rate (Simpson and Baillie 1998). If the same procedure is used for 1998 for comparative purposes, the estimated return is 158, calculated from a catch of 3 and Robertson exploitation rate of 1.9%. This represents a survival rate of 0.17%. Since the latter estimate is based on a catch of 1 tagged coho (expanded to 3), the direct measurement of Conuma escapement (based on 33 tagged coho that returned to the hatchery and 6 tagged carcasses recovered in the river) is preferred. Both calculation methods show that the ocean survival is extremely depressed.

Nitinat Hatchery has not released any CWT'd coho that are approved for exploitation and marine survival analysis since 1996. The data, although unchanged from previous reports, are presented in Table 4C for comparison to Conuma and Robertson.

Since Carnation Creek does not tag coho smolts, the catch cannot be estimated directly. The exploitation rate of Robertson Hatchery is assumed to apply to the Carnation population and by using Equation 3 the catch was estimated to be 5 coho. Using this catch estimate and the known escapement of 272 the survival rate of 5.6% is calculated (Table 4D). The survival of Carnation coho has remained in the 5% - 10% range since 1994.

The marine survivals of the hatcheries and Carnation Creek populations are presented in Figure 4.

As mentioned in Section 5.1.3 some of the in-river spawners were probably of hatchery origin in the Somass system. The analysis of exploitation rate and marine survival depends on an estimate of hatchery origin escapement. If the proportion of hatchery origin coho spawning naturally is significant and especially if it is variable from year to year, the use of hatchery escapements may be deceptive.

5.4. Escapement Enumeration

Table 5 shows AUC estimates of coho to 67 streams during 1995 to 1998. Data from streams having estimates in all four years were analyzed by expressing each annual estimate as the portion it represented of the sum of the estimates over the four years. Proportions were averaged by year over all streams in each of four zones: Areas 20-23, Area 24, Area 25 and Areas 26-27

(Figure 6). There was significant consistency among WCVI Areas: all showed a dramatic increase in escapement during 1998.

The annual swims in July of the mainstem Gold River produced a visual count of 489 adult coho (Table 6). This is a decrease of 52% over the previous brood year however water temperatures were very high and the coho migration timing may have been delayed. A DFO swim count in August 1998 produced a count of 998, which may support the indication of delayed timing however there is no previous data with which to compare this late count to.

Figure 7 shows the relationship between the Carnation Creek weir count, the 'wild' count from the Stamp fishway, and the MOELP summer float count from Gold River. These three populations continue to track each other. Considering the different nature of these numbers (a weir count, a differential count, and a single float count of a summer run) this relationship gives credence to the indicator stream approach: monitoring a few streams may provide accurate estimates of stock assessment parameters for a region. The timing of the Gold River count allows a prediction of later escapements.

The increased escapement from 1997 to 1998 could be the result of three factors.

1. An increase in smolt output.
2. A cessation of commercial and sport fishing pressure.
3. An increase in marine survival.

As measured at Carnation Creek, the ocean survival decreased from 8.5% to 5.6%, contributing to a decrease in escapement. Smolt output increased from 892 to 4942, and the exploitation rate decreased from 35.3% to 1.9%, both contributing to an increase in escapement.

The 1998 adult escapement was a 555% increase over 1997, which was 49. For the same number of smolts and the same exploitation as 1997, the change in ocean survival would have resulted in 35% fewer spawners in 1998. If the 1998 return was the same as 1997, i.e. the smolts and marine survival are held constant, the change in the exploitation rate would yield 73% more spawners. Finally, the greater number of smolts from the1995 brood would produce alone 455% more spawners.

As measured at Robertson River Hatchery, the ocean survival increased from 3.1% to 3.6%, the smolt output increased from 129,570 to 863,524, and the exploitation rate decreased from 35.3% to 1.9%, which all contribute to an increase in escapement. The escapement to the hatchery as reported by MRP, went from 2556 to 30502, an increase of 1200%.

Using a similar substitution to the Carnation example, the change in the ocean survival would have resulted in 16% more spawners, the change in exploitation rate would have resulted in 52% more spawners and the greater number of smolts would have produced 566% more spawners.

Both of these examples show that the decreased exploitation rate and increased smolt output had large effects on the change in escapement from 1997 to 1998. While ocean survival and exploitation rate can be applied to the entire region, we cannot make the same assumption with smolt output which is dependent on specific conditions within each system.

5.5. Juvenile Coho Surveys

The summer of 1998 was extremely dry, with water levels during summer much lower than usual. Several sampling sites were devoid of water, and therefore coho, so these were not included in our analysis. There were also several more sites that consisted solely of isolated pools and had coho fry densities that were exceptionally high. These sites were also excluded from the analysis. Table 7 and Figure 8 show the density of coho fry (age 0) in the pool area combined into area groups. These groupings are the same as the adult snorkel surveys.

Table 8 and Figure 9 show a different treatment of the data. The density is expressed as numbers of age 0 fry per linear metre, rather than pool area and sites that were sampled over all years (1995-1998) were included. The data points corresponding to 1996 to 1998 correspond to 1995 to 1997 brood years. Figure 6 shows escapement trends on the west coast. The data collected for these brood years show a similar pattern. Although escapements in 1998 were roughly four times higher than 1997, it is not expected that the fry will show a similar increase in 1999 because of the density dependent mechanisms governing fresh water survival. Outmigration of coho fry, while affected by several factors, is also positively density dependent (Holtby and Hartman, 1982).

6. Conclusions and Recommendations

- Marine survival of WCVI coho remained relatively poor; Conuma coho survival appears especially poor and may warrant further investigation.
- Most streams showed dramatic increases in coho escapement during 1998; since marine survival was relatively unchanged, the increase is likely due to severe fishing restrictions imposed in 1998 and the possibility that smolt outputs may have been better in 1997 as well.
- 1999 coho fry surveys will provide the earliest indication of any positive impact on production from increased escapements; therefore, it is critical that these projects be funded during FY 1999/2000 so that this information will be available for management of the fishery in 2001.
- Extension of WCVI escapement surveys to provide adequate survey coverage of coho migration should continue during 1999/2000.
- In-river escapement of hatchery origin coho will affect the marine survival and exploitation analysis of the Robertson River population and the applications of this data such estimates of ocean survival of Carnation and Conuma coho.

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8. Tables

Table 1. Coho catch in the troll fishery of southwest and northwest Vancouver Island, 1970 to 1998 (DFO Salmon Stock Assessment database).

	SWTR	NWTR	TOTAL		SWTR	NWTR	TOTAL
1970	526,594	252,839	779,433	1985	1,012,020	377,035	1,389,055
1971	1,509,385	666,334	2,175,719	1986	1,546,331	610,502	2,156,833
1972	601,387	387,038	988,425	1987	1,295,914	525,108	1,821,022
1973	1,127,748	278,553	1,406,301	1988	1,039,887	555,914	1,595,801
1974	1,230,483	413,520	1,644,003	1989	1,373,216	578,793	1,952,009
1975	524,507	256,741	781,248	1990	1,134,092	729,516	1,863,608
1976	1,136,783	503,476	1,640,259	1991	1,225,300	664,646	1,889,946
1977	1,244,496	323,383	1,567,879	1992	736,329	935,493	1,671,822
1978	955,328	404,946	1,360,274	1993	531,812	421,999	953,811
1979	1,365,077	547,801	1,912,878	1994	1,044,142	207,675	1,251,817
1980	1,325,602	412,868	1,738,470	1995	1,074,334	277,961	1,352,295
1981	1,026,915	358,408	1,385,323	1996	554,181	237,231	791,412
1982	1,315,815	461,621	1,777,436	1997	3	35	38
1983	1,689,250	478,188	2,167,438	1998	0	0	0
1984	1,668,409	503,757	2,172,166				

Table 2. Coho counts from Stamp Falls and Robertson Creek Hatchery (HEB records). Their difference may be an indicator of wild escapement to the upper Stamp system.

	Stamp Falls		Robertson Hatchery		(Stamp - Robertson)	
Return Year	**Jacks**	**Adults**	**Jacks**	**Adults**	**Jacks**	**Adults**
1986			2,396	28,771		
1987			2,547	22,982		
1988			12,059	6616		
1989			6,723	17508		
1990	5,331	45,441	3,686	18883	1,645	26,558
1991	7,572	37,949	5,254	21801	2,318	16,148
1992	7,568	50,148	4,878	24567	2,690	25,581
1993	861	15,480	67	9293 *	794	6,187
1994	2,986	977	409	252	2,577	725
1995	3,198	18,380	786	7032 **	2,412	11,348
1996	3,885	15,665	943	10432	2,942	5,233
1997	3,315	6,496	703	3145	2,612	3,351
1998	5005	70711	1836	36658	3169	34,053

1996 to 1998 Stamp Falls counts have been adjusted for observer error.

* Includes 1980 coho released back into Stamp River.

* * Includes 2307 coho released back into Stamp River.

Table 3. Total Unallowable Mortality Table. 1998 encounters and estimated mortalities of coho salmon in west Vancouver Island fisheries.

FISHERY		Encounters	Estimated Mortalities
TROLL			
Sockeye	G Troll - Barkley Sound	20	5
Chum	G Troll - WCVI	149	39
NETS			
Chum	Net - Area B Seine - Nitinat (Chum)(live coho)	1987	497
Chum	Net - Area B Seine - Nitinat (Chum)(dead coho)	1715	1715
Chum	Net - Area B Seine - Nootka Area 25 (Chum)(live coho)	89	22
Chum	Net - Area B Seine - Nootka Area 25 (Chum)(dead coho)	27	27
Sockeye	Net - Area D Gillnet - Barkley Sound (Sockeye)	131	79
Chum	Net - Area D Gillnet - Nootka (Chum) - (Outer Nootka, Tlupana, Esperanza)	679	407
Chum	Net - Area E Gillnet - Nitinat (Chum)(Area 21)	77	46
SPORT			
Sockeye	Sport - J de F ((Area 19C to 19E) to Aug.15)	926	93
Sockeye	Sport - J de F ((Area 19C to 19E) to Aug.15 and again starting Oct. 1)	104	10
Sockeye	Sport - J de F (Sooke to Sheringham starting Oct. 1)	646	65
Sockeye	Sport - J de F (Port Renfrew area starting Oct. 1)	500	50
Sockeye	Sport - J de F (Nitnat area starting Oct. 1)	0	0
Sockeye	Sport - WCVI (Areas 23/123)	24305	2431
Sockeye	Sport - WCVI (Areas 24/124)	14451	1445
Sockeye	Sport - WCVI (Areas 25/125)	5359	536
Sockeye	Sport - WCVI (Areas 26/126)	473	47
Sockeye	Sport - WCVI (Areas 27/127)	500	50
TEST and EXPERIMENTAL			
Sockeye	Aboriginal test troll - South Coast / WC Vancouver Island *****	68	18
Chum	Test Gillnet/Seine - Nootka (2 vessels, Sept. 16 - Oct. 30)	3	2
Chum	Test Gillnet - Nitnat (7 vessels, Sept. 25-Oct. 8) (dead coho)	25	25
Chum	Test Gillnet - Nitnat (7 vessels, Sept. 25-Oct. 8)(live coho)	36	22
Chum	Test Gillnet - Nitnat Lake (1 vessel, Sept. 30-Nov.1)	3	2
Chum	Test Seine - Nitnat Area 21 (1 vessel)	68	17
Chum	Test Seine - Alberni Inlet Area 23 (1 vessel)	15	4
Chum	Test Seine - Clayoquot Area 24 (1 vessel)	110	28
Chum	Test Seine - Nootka Area 25 (1 vessel)	341	85
Chum	Test Seine - Kyuquot Area 26 (1 vessel, Oct. 8-30)	57	14
Chum	Test Seine - Prospect Pt. Area 27	10	3
Sockeye	**Selective** Fishery - Barkley Sound **S**eine (dead coho)	24	24
Sockeye	**Selective** Fishery - Barkley Sound **S**eine (live coho)	16894	845
Sockeye	**Selective** Fishery - Barkley Sound **G**illnet (dead coho)	541	541
Sockeye	**Selective** Fishery - Barkley Sound **G**illnet (live coho)	905	525
Sockeye	**Selective** Fishery - Barkley Sound **T**roll (dead coho)	34	34
Sockeye	**Selective** Fishery - Barkley Sound **T**roll (live coho)	312	59
Sockeye	**Selective** Fishery - Stamp River Sport Recreational	0	0
Sockeye	PSC Gillnet - Area 20 (June 21- Aug.21)	364	218
Sockeye	PSC Seine - Area 20 (July 24-Aug.25)	1042	261
Sockeye	Test G Troll - Area 127/27	692	180
Sockeye	Sport - J de F (Sooke to Sheringham - to Aug.31 then closed to Sept. 30)	8232	823
Sockeye	Sport - J de F (Area 19 C,D,E - Aug.15 - Sept.30)	361	36
Sockeye	Sport - J de F (Port Renfrew area to Sept. 30)	3198	320
Sockeye	Sport - J de F (Nitnat area to Sept. 30)	41	4
	Total	85514	11654

Table 4A. Expanded CWT data by catch region for adult coho from Robertson Creek.

	Return Year											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
No. Released	92824	253707	794227	469997	387536	485213	1117774	991262	980084	1269181	1601236	1459566
Catch Region												
NTR	8	55	705	468	30	0	82	624	783	31	684	583
NCTR	94	94	790	297	200	62	333	709	729	52	103	218
SCTR	219	398	2605	911	614	202	456	2155	2490	943	2729	1221
NWTR	1626	2060	9357	12496	3554	2958	5821	12402	17995	8563	18657	9470
SWTR	2343	6601	6363	10203	4351	2945	8973	15082	20378	6166	14003	9512
GSTR	3	0	36	19	0	0	0	0	0	0	0	0
JFTR	0	15	0	0	0	0	0	0	0	0	0	0
NN	0	26	0	402	53	0	0	112	150	0	58	0
CN	9	25	178	245	76	0	332	130	5	0	0	82
NWVN	103	259	0	0	0	9	0	0	5	0	0	0
SWVN	22	1216	3249	95	559	144	0	620	1869	0	76	53
JSN	78	72	799	34	35	0	129	704	0	0	317	0
GSN	0	0	0	0	0	0	0	0	0	0	0	0
FGN	0	0	0	0	0	0	0	0	0	0	0	0
JFN	69	340	639	93	16	144	0	0	252	244	125	258
FSN	0	0	0	0	0	0	0	0	0	0	0	0
NSPT	0	0	0	0	0	0	0	0	0	0	0	0
CSPT	0	18	0	0	0	44	69	124	87	26	0	0
ACSPT	8	0	62	0	30	37	0	82	56	35	1497	127
WSPT	72	229	471	175	30	112	92	579	305	252	1040	1638
GSPTN	0	19	63	47	0	0	48	117	0	23	242	0
GSPTS	0	20	65	47	0	0	0	45	64	20	0	0
JFSPT	25	0	0	98	0	0	0	68	85	0	0	0
FWSP	17	0	0	0	30	35	0	69	133	0	416	577
WASHINGTON	477	707	696	387	215	131	262	235	553	55	982	89
ALASKA TOTAL	6	0	0	0	19	30	0	317	524	25	66	128
TOTAL BC TROLL	4292	9223	19856	24393	8748	6167	15665	30972	42375	15755	36176	21004
TOTAL BC NET	280	1937	4864	868	739	297	461	1566	2281	244	576	393
TOTAL BC SPORT	122	286	661	365	91	228	209	1082	729	355	3195	2342
ESCAPEMENT	4611	10939	37800	20516	11491	6935	8235	16055	14889	9524	23294	18387
% EXPLOITATION "A"	52.9%	52.6%	40.8%	55.9%	46.1%	49.7%	66.8%	68.0%	75.7%	63.3%	63.8%	56.6%
% EXPLOITATION "B"	52.7%	52.6%	40.8%	55.9%	45.9%	49.5%	66.8%	67.9%	75.5%	63.3%	63.1%	55.2%
% SURVIVAL	10.5%	9.1%	8.0%	9.9%	5.5%	2.8%	2.2%	5.1%	6.3%	2.0%	4.0%	2.9%

Table 4A. Continued

	Return Year										
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. Released	1155807	1144494	547233	1195149	1548640	1428737	770779	775457	807278	129570	863524
Catch Region											
NTR	0	287	1092	778	864	1332	0	321	89	233	0
NCTR	0	31	158	679	0	0	0	0	0	0	0
SCTR	341	669	1607	242	799	508	0	0	0	0	0
NWTR	3239	13809	18771	16734	15787	10122	50	1416	1962	0	0
SWTR	7056	14905	6800	14410	24262	8694	183	2481	1936	0	0
GSTR	0	0	53	0	0	0	0	0	0	0	0
JFTR	0	0	0	0	0	0	0	0	0	0	0
NN	0	50	136	115	0	95	0	0	43	31	0
CN	0	0	103	0	121	0	0	0	0	0	0
NWVN	0	0	0	0	0	0	0	0	0	0	0
SWVN	395	1497	315	49	312	0	0	0	0	0	0
JSN	49	275	326	138	0	0	0	0	95	21	0
GSN	0	0	0	0	0	0	0	0	0	0	0
FGN	0	0	0	0	0	0	0	0	0	0	0
JFN	104	3234	156	1647	691	94	0	0	0	5	0
FSN	0	0	0	0	0	0	0	0	0	0	0
NSPT	0	0	0	61	0	0	0	0	153	27	0
CSPT	0	0	0	99	230	0	0	0	0	50	0
ACSPT	223	180	97	5572	0	0	0	0	76	96	0
WSPT	3852	3119	2667	3191	6415	2465	0	1484	2617	694	87
GSPTN	0	0	0	185	0	0	0	0	0	0	0
GSPTS	0	0	0	0	386	0	0	0	0	0	0
JFSPT	0	195	211	0	181	0	0	0	258	37	0
FWSP	0	461	281	0	214	393	0	0	0	0	87
WASHINGTON	95	1072	299	1046	878	552	0	0	74	12	173
ALASKA TOTAL	0	0	240	280	628	1075	0	93	642	190	325
TOTAL BC TROLL	10636	29701	28482	32843	41712	20655	232	4219	3987	233	0
TOTAL BC NET	548	5056	1036	1949	1124	189	0	0	138	58	0
TOTAL BC SPORT	4075	3954	3256	9108	7426	2858	0	1484	3104	904	175
ESCAPEMENT	5943	16659	15648	23990	19649	7693	141	3946	6452	2556	30502
% EXPLOITATION "A"	72.1%	70.5%	68.0%	65.3%	72.5%	76.7%	62.3%	59.5%	55.2%	35.3%	2.2%
% EXPLOITATION "B"	72.1%	69.7%	67.5%	65.3%	72.2%	75.5%	62.3%	59.5%	55.2%	35.3%	1.9%
% SURVIVAL	1.8%	4.9%	8.9%	5.8%	4.6%	2.3%	0.05%	1.3%	1.8%	3.1%	3.6%

Table 4B. Expanded CWT data by catch region for adult coho from Conuma Hatchery. Exploitation is assumed to be the same as Robertson River, except for 1998 where it was calculated from Conuma data.

	Return Year												
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. Released	75135	100000	125341	92890	124231	121975	150159	113073	111914	111702	85448	22787	95638
Catch Region													
NTR	4	22	68	99	57	0	0	0	0	42	9	0	0
NCTR	6	0	17	10	0	0	0	0	0	0	0	0	0
SCTR	347	104	103	98	41	31	210	0	0	0	0	0	0
NWTR	4228	2935	2978	1569	2716	6427	7866	986	63	2376	1234	0	0
SWTR	1747	1341	1597	1203	2427	1380	2405	425	84	1332	402	0	0
GSTR	0	7	31	0	0	0	0	0	0	0	0	0	0
JFTR	0	0	0	0	0	0	0	0	0	0	0	0	0
NN	0	0	0	0	0	0	0	0	0	16	0	0	0
CN	0	0	0	0	0	0	0	0	0	6	0	0	0
NWVN	681	116	0	0	0	0	111	5	3	6	0	0	0
SWVN	31	17	0	0	0	18	0	0	0	0	0	0	0
JSN	12	0	25	14	0	0	18	0	0	0	0	0	0
GSN	20	0	0	0	0	0	0	0	0	0	0	0	0
FGN	0	0	0	0	0	0	0	0	0	0	0	0	0
JFN	40	29	0	66	0	0	9	0	0	0	0	0	0
FSN	0	0	0	0	0	0	0	0	0	0	0	0	0
NSPT	0	0	0	0	0	0	0	0	0	0	0	0	0
CSPT	13	0	25	0	0	0	0	12	0	9	0	0	0
ACSPT	0	0	0	0	0	0	0	0	0	0	0	0	0
WSPT	1017	2333	2169	455	2021	1233	2529	548	46	895	1843	50	0
GSPTN	15	0	41	0	0	0	0	0	0	0	0	0	0
GSPTS	0	0	0	0	0	51	0	0	0	0	0	0	0
JFSPT	0	0	0	0	0	0	23	0	0	0	0	0	0
FWSP	0	0	0	0	0	0	26	0	0	0	0	0	0
WASHINGTON	49	37	0	7	0	6	0	4	0	0	0	0	3
ALASKA	0	0	0	0	0	0	0	0	0	28	0	0	0
TOTAL BC TROLL	6332	4408	4793	2978	5241	7838	10481	1411	148	3750	1645	0	0
TOTAL BC NET	785	162	25	80	0	18	138	5	3	27	0	0	0
TOTAL BC SPORT	1045	2333	2235	455	2021	1284	2578	560	46	904	1843	50	0
Est'd Escapement	4798	5629	2730	1533	3502	4851	5074	642	119	3206	2832	92	253
Assumed Exploitation	63.1%	55.2%	72.1%	69.7%	67.5%	65.3%	72.2%	75.5%	62.3%	59.5%	55.2%	35.3%	1.2%
Est'd Survival	17.3%	12.6%	7.8%	5.4%	8.7%	11.5%	12.2%	2.3%	0.28%	7.1%	7.4%	0.62%	0.27%

Table 4C. Expanded CWT data by catch region for adult coho from Nitinat Hatchery.

	Return Year							
	1989	1990	1991	1992	1993	1994	1995	1996
No. Released	11530	0	19089	46467	78728	95442	121569	89060
Catch Region								
NTR	49	0	58	64	61	9	43	0
NCTR	0	0	4	0	0	0	3	0
SCTR	11	0	9	82	0	0	0	0
NWTR	148	0	523	721	445	91	876	182
SWTR	218	0	362	807	312	84	2500	209
GSTR	0	0	0	0	0	0	0	0
JFTR	0	0	0	0	0	0	0	0
NN	10	0	4	6	0	0	0	0
CN	0	0	0	0	0	0	0	0
NWVN	0	0	0	0	0	0	0	0
SWVN	23	0	69	312	65	7	122	2
JSN	0	0	0	27	3	17	13	0
GSN	0	0	0	0	0	0	0	0
FGN	0	0	0	0	0	0	0	0
JFN	8	0	10	29	0	0	13	0
FSN	0	0	0	0	0	0	0	0
NSPT	0	0	0	0	0	0	0	0
CSPT	0	0	0	0	0	0	0	0
ACSPT	0	0	0	0	0	0	0	0
WSPT	31	0	103	297	53	12	375	42
GSPTN	0	0	0	5	0	0	0	0
GSPTS	0	0	0	0	0	0	0	0
JFSPT	0	0	0	0	0	5	47	0
FWSP	0	0	0	0	0	0	0	0
WASHINGTON	5	0	16	19	34	0	51	0
ALASKA TOTAL	5	0	22	110	60	0	61	27
TOTAL BC TROLL	427	0	956	1675	818	183	3423	391
TOTAL BC NET	41	0	83	374	67	24	149	2
TOTAL BC SPORT	31	0	103	302	53	16	422	42
Est'd Escapement	221	0	626	955	335	135	2795	375
Assumed Exploitation	69.7%	67.5%	65.3%	72.2%	75.5%	62.3%	59.5%	55.2%
Est'd Survival	6.3%		9.5%	7.4%	1.7%	0.4%	5.7%	0.9%

Table 4D. Exploitation and marine survival estimates for Carnation Creek, 1976 to 1998.

Return Year	Smolt Enumeration	Escapement	Exploitation Rate	Estimated Catch	Estimated Survival Rate
1976	2121	123	52.7%	137	12.3%
1977	3062	127	52.6%	141	8.8%
1978	2560	102	40.8%	70	6.7%
1979	4646	312	55.9%	396	15.2%
1980	3530	175	45.9%	149	9.2%
1981	4567	119	49.5%	116	5.2%
1982	4164	174	66.8%	351	12.6%
1983	3470	103	67.9%	218	9.2%
1984	3745	49	75.5%	151	5.3%
1985	3113	69	63.3%	119	6.0%
1986	1978	119	63.1%	204	16.3%
1987	2833	64	55.2%	79	5.0%
1988	2648	57	72.1%	147	7.7%
1989	2712	156	69.7%	358	19.0%
1990	3862	195	67.5%	404	15.5%
1991	3222	211	65.3%	398	18.9%
1992	3103	107	72.2%	278	12.4%
1993	5253	95	75.5%	293	7.4%
1994	3989	9	62.3%	15	0.6%
1995	4759	175	59.5%	257	9.1%
1996	3480	74	55.2%	91	4.7%
1997	892	49	35.3%	27	8.5%
1998	4942	272	1.9%	5	5.6%

Table 5. Area-under-the-curve coho escapement estimates from the WCVI Chinook Enumeration Project, 1995-1998. No, light and dark shading indicates low, moderate, or better than moderate confidence in the estimates, respectively.

Area	**Stream**	**Tributary**	**Adults**			
			1995	**1996**	**1997**	**1998**
20	San Juan		19542	18919	4665	49959
	Gordon		16	**480**	283	668
	Tugwell					**113**
	Muir					**775**
21	Klanawa					537
		Ralf				40
		Blue				31
	Cheewhat					49
22	Nitinat		3564		**1109**	4683
		Little Nitinat			30	123
		No-name			20	98
		Worthless			66	155
		Parker			90	154
		Caycuse			26	92
		Campus			34	56
	Doobah					21
23	Sarita		**124**	**58**	**162**	895
	Nahmint		**84**	**53**	69	424
	Effingham		200	**8**		
	Drinkwater					155
	McBride					358
	Taylor					
	Toquart					**3170**
24	Kennedy		**2760**			
		Clayoquot	1042			
	Bedwell		**816**		812	
		Ursus	**1383**		756	
	Bedwell/Ursus		**2004**	**479**	908	3689
	Moyeha		**1370**	746	657	**5137**
	Megin		918	**357**	649	2007

Table 5. Continued.

Area	Stream	Tributary	Adults			
			1995	**1996**	**1997**	**1998**
25	Burman		**888**	**714**	510	860
	Gold			443	947	N/A
		Muchalat			33	
		Oktwanch		**225**	295	
	Kleeptee		13			
	Tlupana		**609**	**216**	505	1099
	Conuma		**1254**	**2167**	**658**	1645
	Canton		**549**	**393**	**323**	**1369**
	Sucwoa		**156**	**98**	**107**	790
	Deserted		**130**	**5**	**18**	43
	Tsowwin			**276**	1238	973
	Leiner		**143**	**196**	181	507
	Tahsis		**308**	**99**	**667**	773
	Black		1			116
	Zeballos		121	**170**	**555**	578
	Espinosa		**8**			99
	Park		50			73
26	Kaouk		1080	813	1263	**5077**
	Artlish		160	212	678	**2002**
	Tahsish		1186	409	564	1824
		Silburn	11			
	Tahsish/Silburn		1190			
	Kashutl		28			**337**
	Chamiss		7			**80**
	Amai		50			**426**
	Easy		20			**477**
	Kauwinch		500			**1083**
	Narrowgut		30			**1269**
27	Klaskish		221	322	102	458
	Klootchlimmis				28	**1075**
	Cayeghle/Colonial				467	**3541**
	Marble		1833	743	638	**1634**
		Benson		188		777
		Link		161		699
	Mahatta					2161
	Goodspeed					**2776**
	Hathaway					550
	Keith					1185
	Wanokana					418

Table 6. Swim counts by BC Ministry of Environment, Lands, and Parks staff of summer run coho in Gold River, 1977 to 1998.

Return Year	Count of Large Coho	Return Year	Count of Large Coho
1977	300	1988	350
1978	900	1989	643
1979	1,600	1990	437
1980	500	1991	959
1981	1,400	1992	981
1982	700	1993	151
1983	500	1994	61
1984	380	1995	1,019
1985	480	1996	442
1986	759	1997	150
1987	--	1998	489

Table 7. Density of coho fry (number of age 0 fry per square metre) in west coast Vancouver Island streams, 1991 to 1998. This table includes data from all sites.

	1991	1992	1993	1994	1995	1996	1997	1998
20-23	1.57	1.20	1.03	1.87	1.48	3.47	4.66	4.66
24					0.49	1.39	1.91	2.26
25					2.60	3.91	2.70	2.27
26/27					2.76	2.71	3.88	2.03

Table 8. Density of coho fry (number of age 0 fry per metre) in west coast Vancouver Island streams, 1994 to 1998. This table only includes data from sites that were sampled in all years. The number in brackets under 'Area' indicates the number of sample sites included.

Area	Year			
	1995	1996	1997	1998
20 (3)	1.73	6.89	5.54	5.88
21/22 (2)	0.65	4.13	2.69	2.76
23 (3)	1.57	4.81	3.17	4.27
25 (4)	3.22	5.46	1.35	2.76
27 (3)	2.12	5.48	4.96	2.87

9. Figures

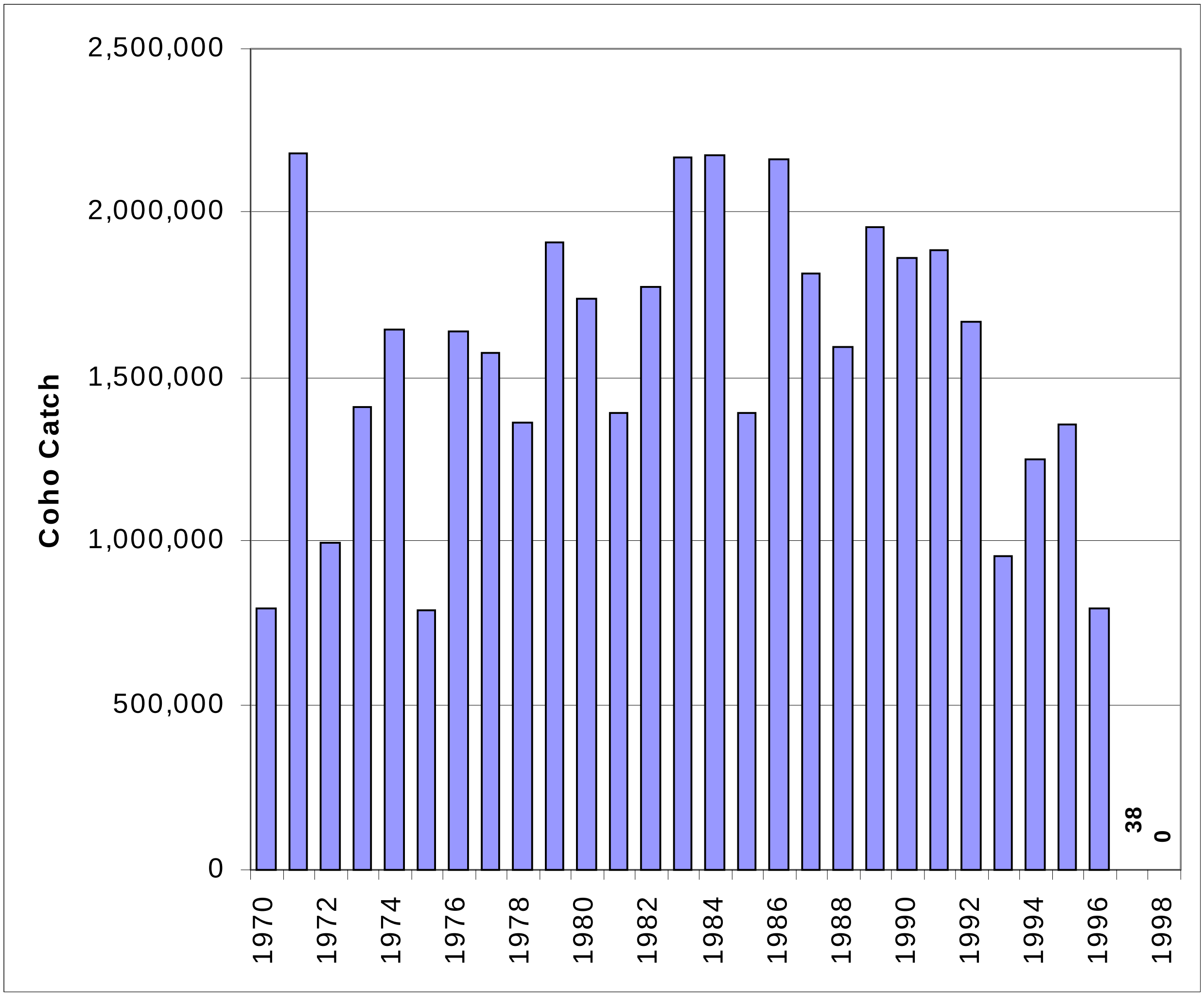

Figure 1. Coho catch in the west coast Vancouver Island troll fishery, 1970 to 1998. There were no directed troll fisheries on coho in 1997 and 1998.

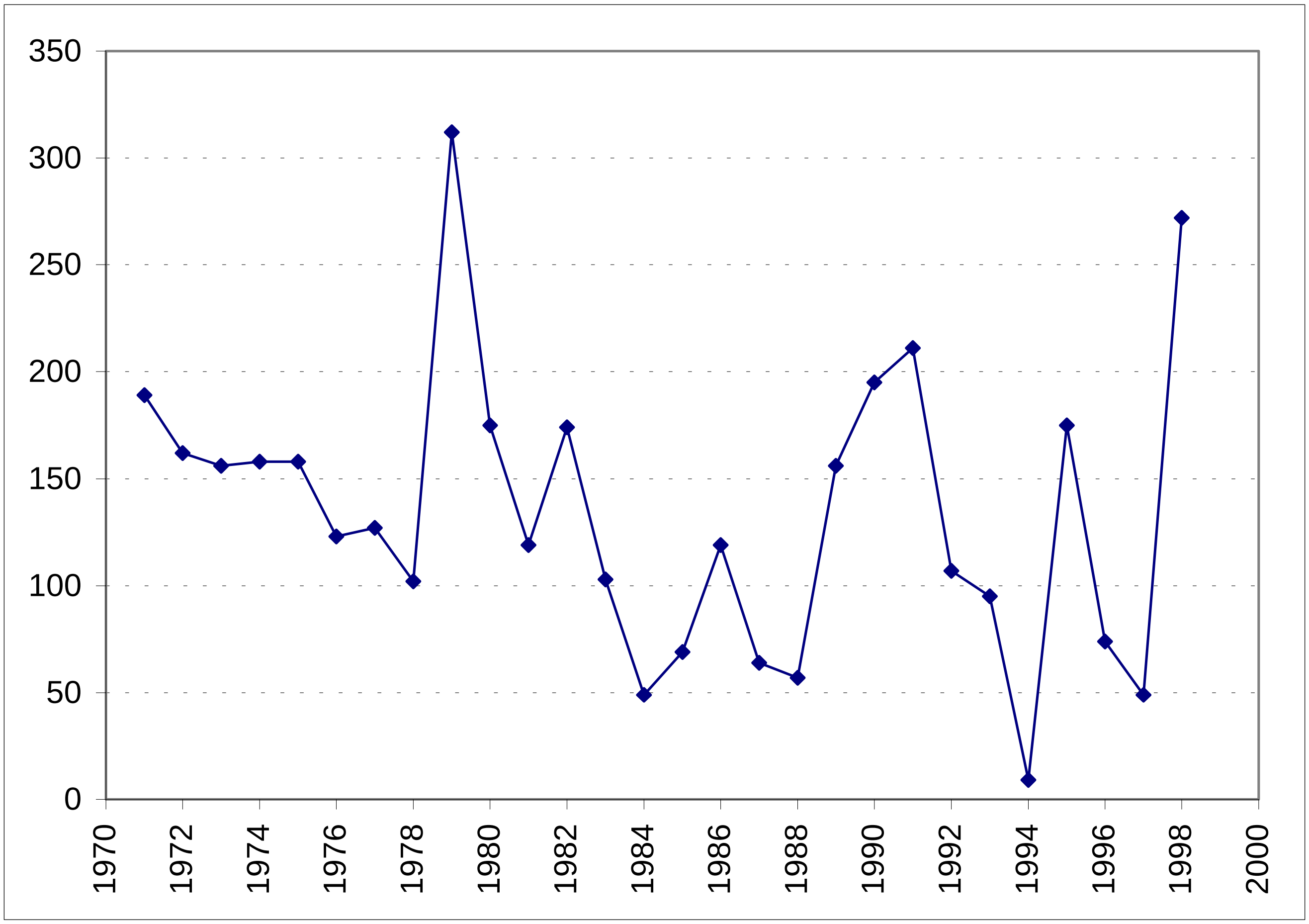

Figure 2. Adult coho escapements to Carnation Creek by return year, 1971 – 1998.

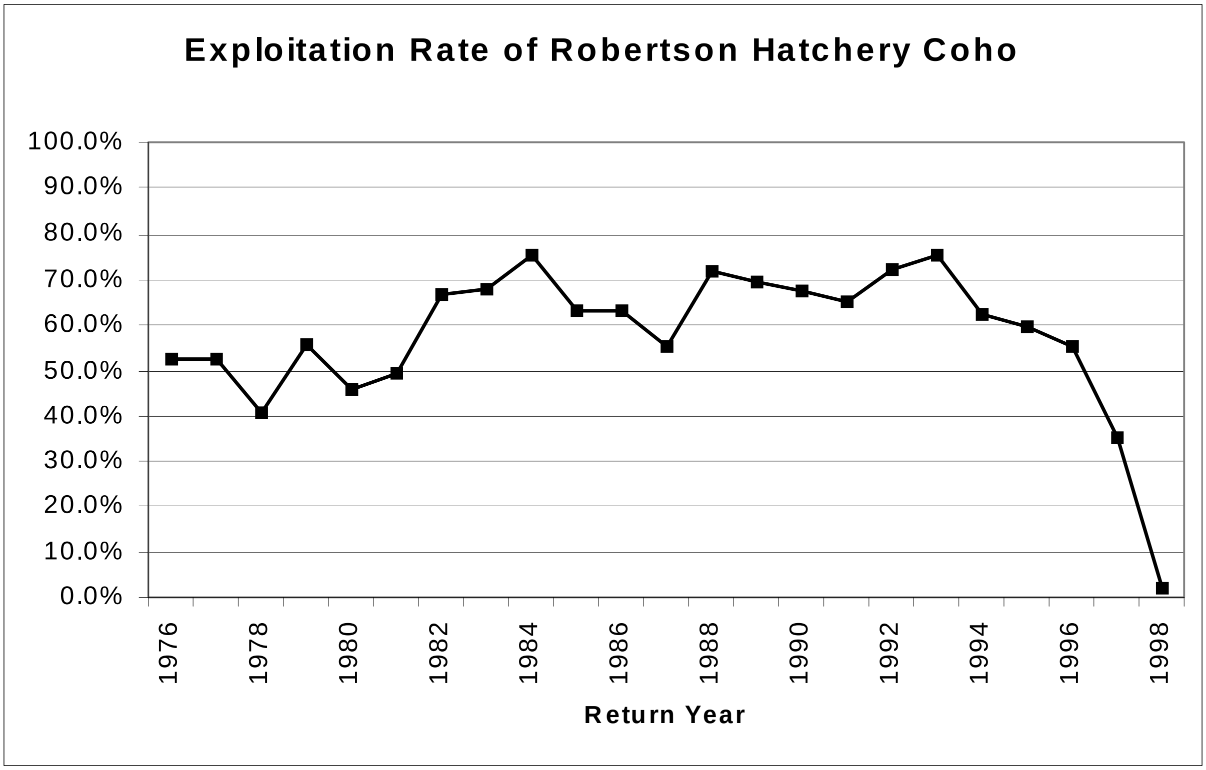

Figure 3. Exploitation rate of Robertson Creek coho, 1976 to 1998. Includes Canada and US commercial and sport operations.

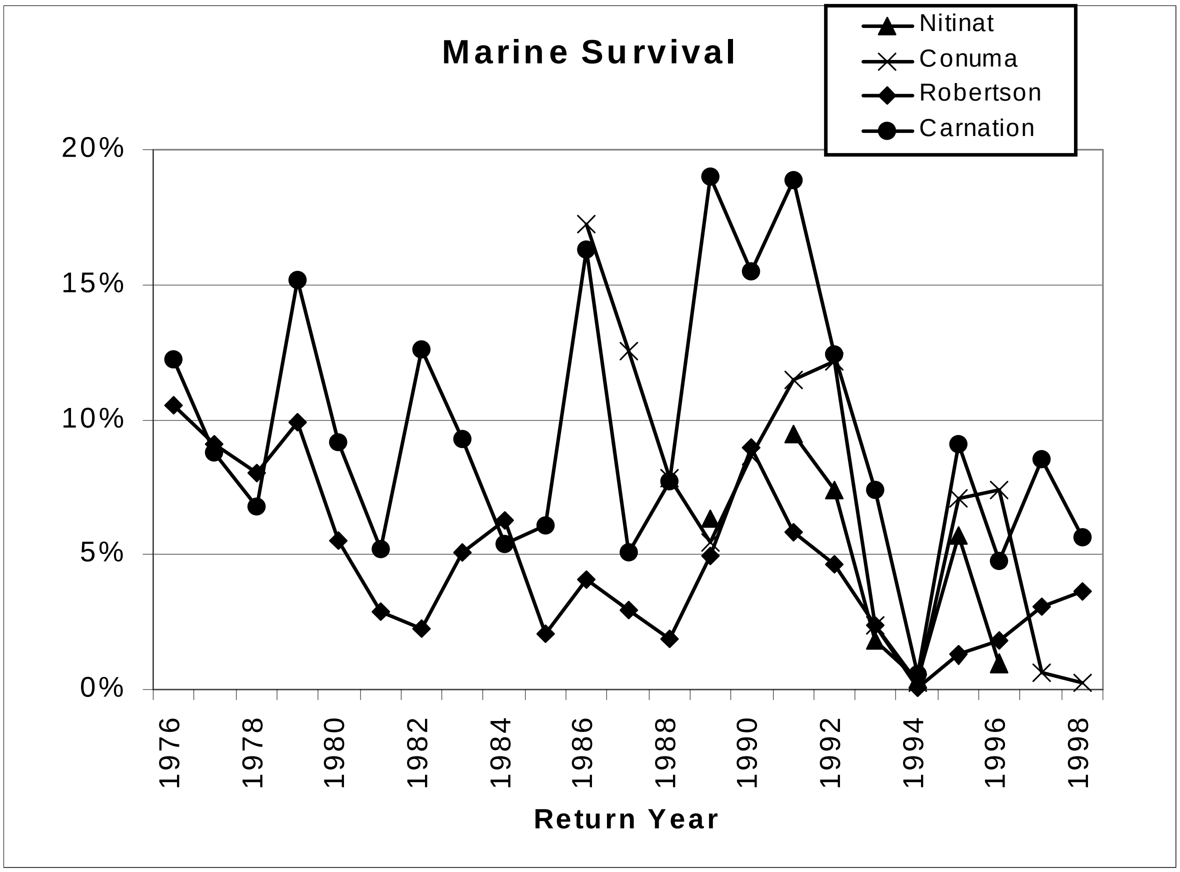

Figure 4. Estimated smolt to adult survival at Robertson, Conuma, and Nitinat Hatcheries, and Carnation Creek, 1976 to 1998.

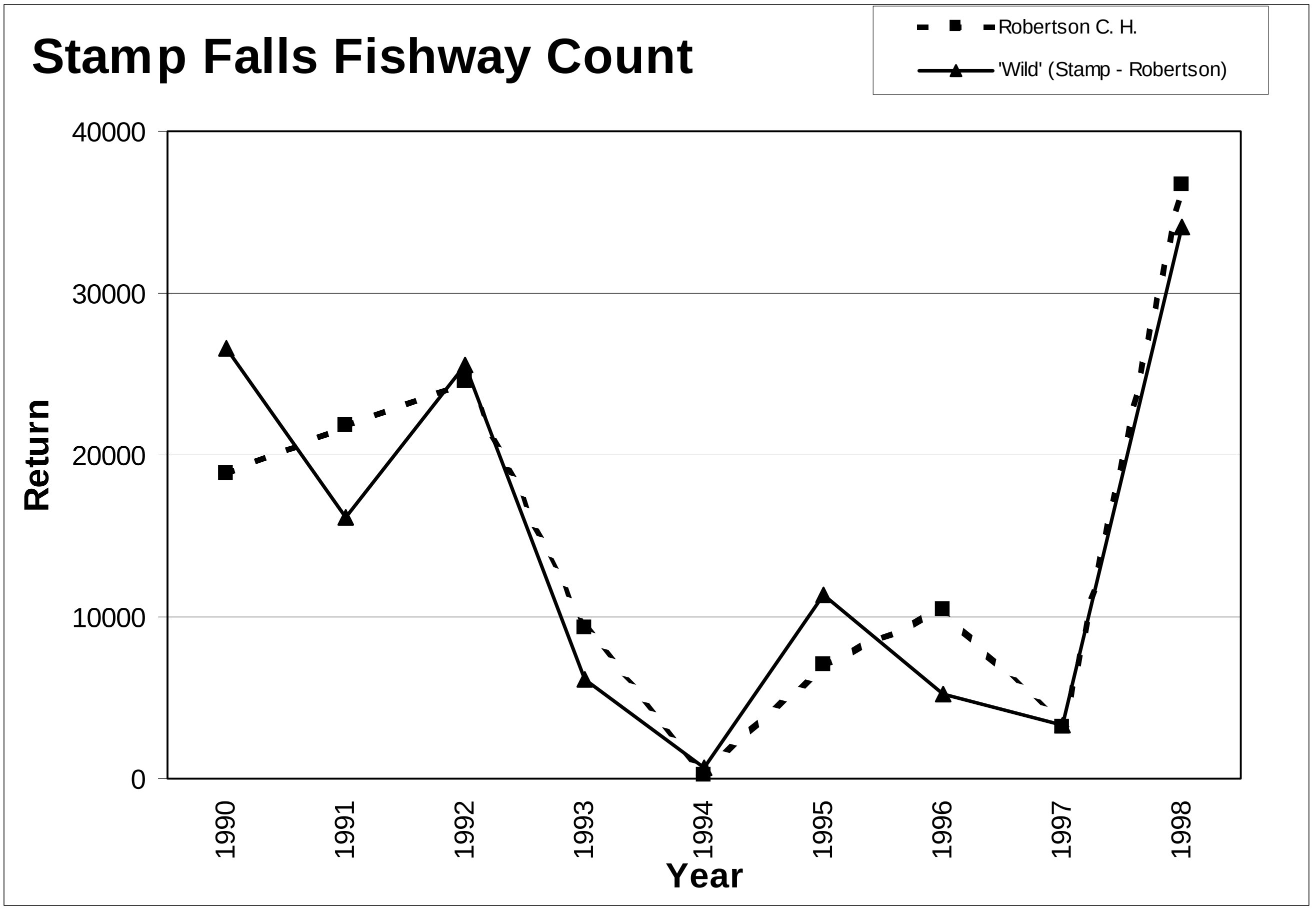

Figure 5. Hatchery and 'Wild' Components of Coho Escapement to the Stamp River. Stamp Falls counts minus Robertson C. H. swim-ins are used as an approximation of wild escapement.

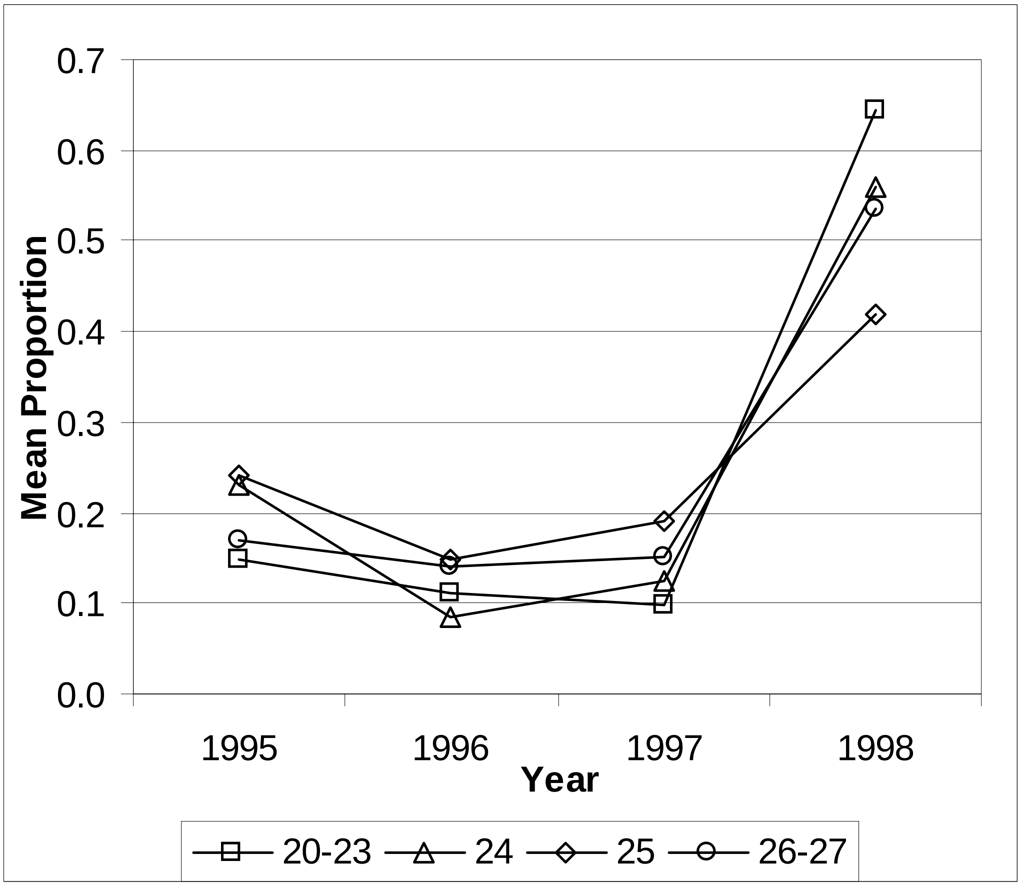

Figure. 6. Estimates of coho escapements, by Area, to streams surveyed by the WCVI Chinook Enumeration Project, 1995 to 1998. Each year's escapement to a stream was expressed as the proportion it represented of the four year total escapement to the stream. Proportions were averaged by year over all streams in the Area.

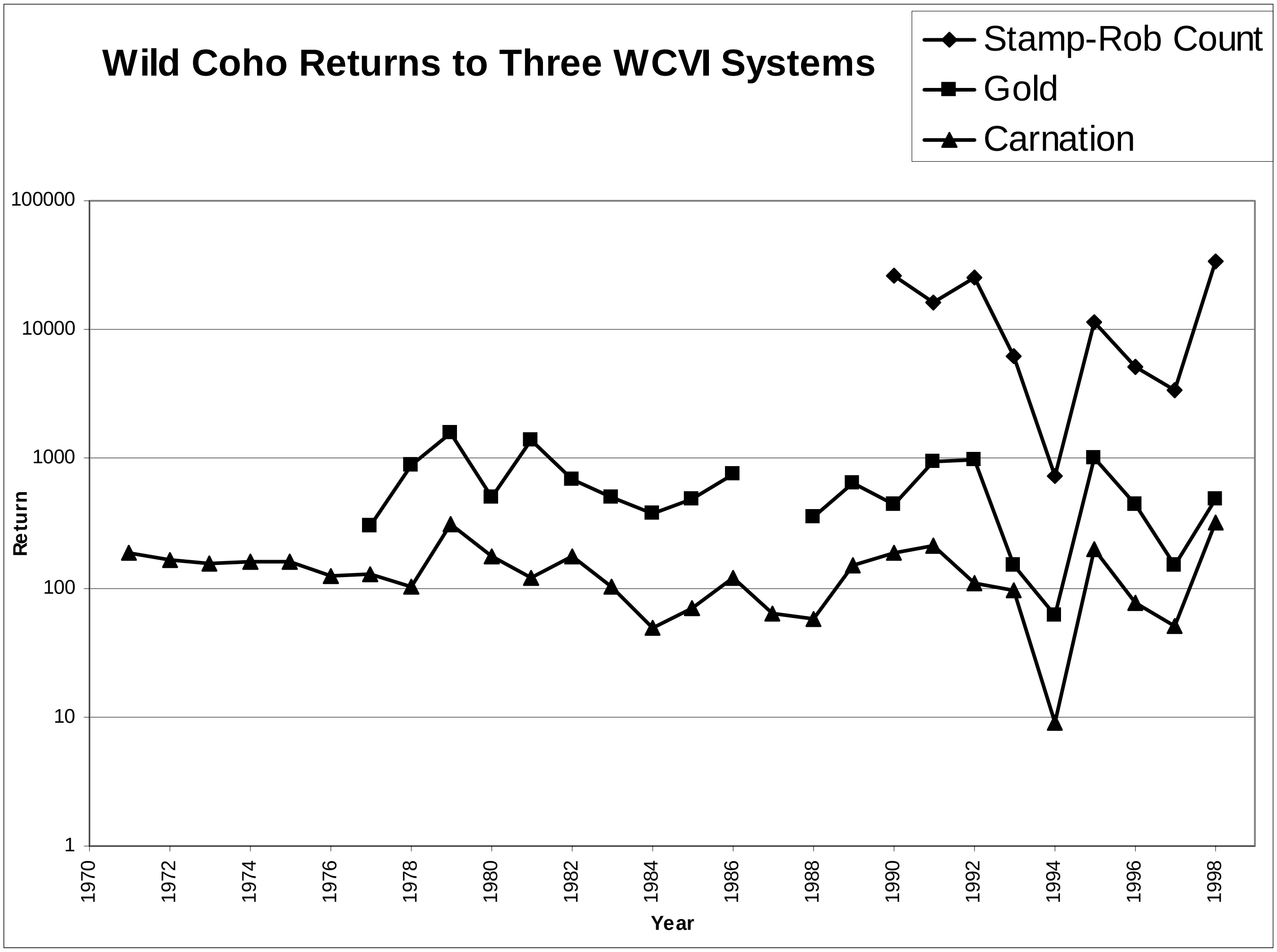

Figure. 7. Escapements of adult coho to Robertson River, Gold River and Carnation Creek, 1971 to 1998.

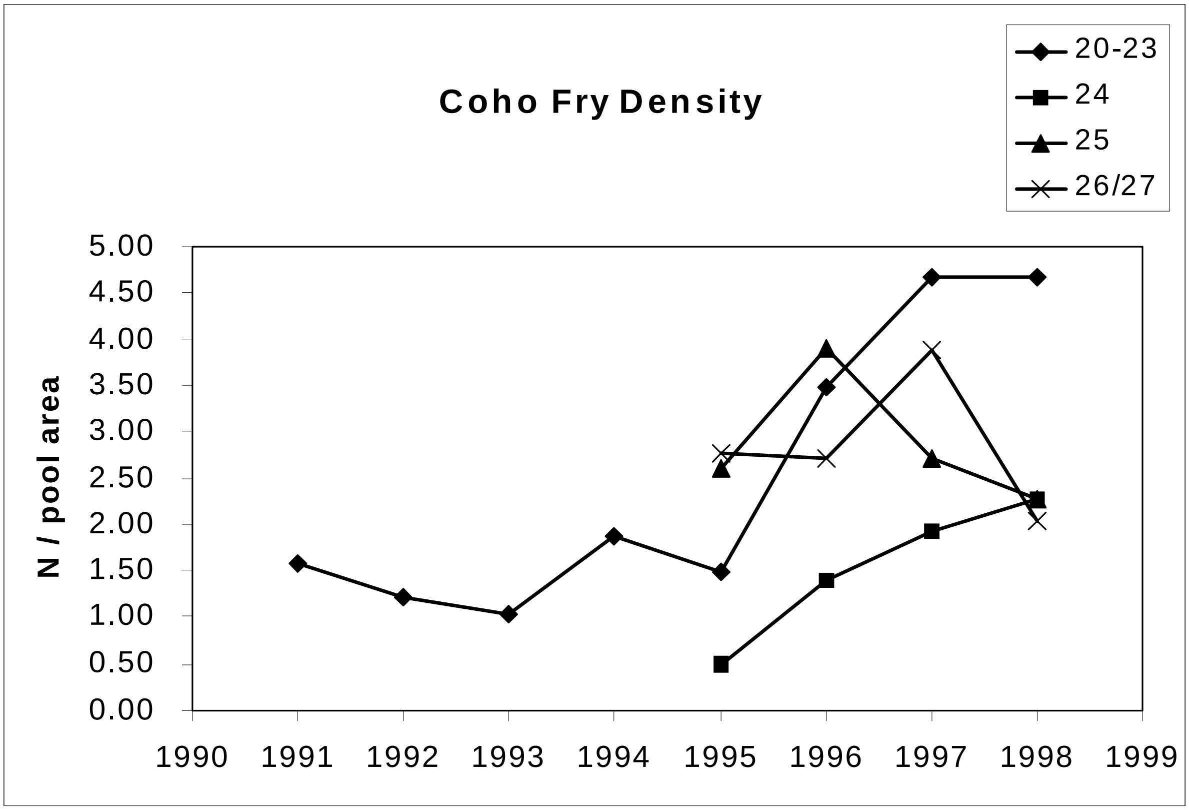

Figure. 8. Density of coho fry (age 0) per pool area from west coast Vancouver Island streams.

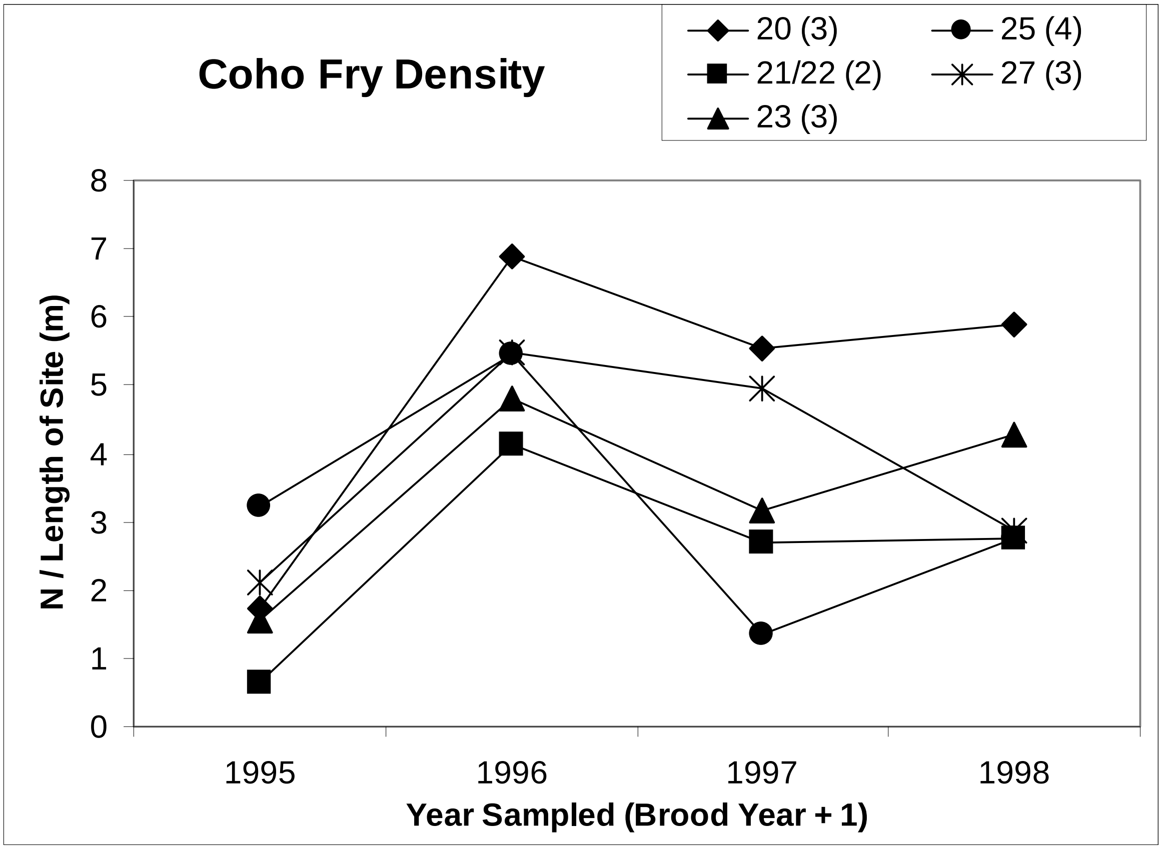

Figure 9. Density of coho fry (age 0) per linear metre from west coast Vancouver Island streams.