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A Preliminary Report on the Chinook Productivity Study Conducted on the Cowichan River During 1990 and 1991

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A PRELIMINARY REPORT ON THE CHINOOK PRODUCTIVITY STUDY CONDUCTED ON THE COWICHAN RIVER DURING 1990 AND 1991

by

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Nagtegaal, D. A., J. Candy and B. Riddell. 1994. A preliminary report on the chinook productivity study conducted on the Cowichan River during 1990 and 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2265: 71 p.

In 1990 and 1991, the Biological Sciences Branch, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this study include: i) enumeration of spawners, ii) estimation of native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) data collection. In 1991, a mark-recapture study was also conducted to augment the fence count. Total returns of adult chinook to the Cowichan River were estimated to be 5,094 in 1990 and 5,065 in 1991. These were considered to be minimum estimates since in both years the enumeration fence was washed out due to high water levels prior to the end of the run. Fishery Officers estimated adult chinook returns in 1990 to be 5,300 and in 1991 to be 10,000. In addition, a water management plan was executed by the Department of Fisheries and Oceans, Fisheries Branch, in conjunction with the Ministry of Environment and Parks and Fletcher Challenge Canada, Ltd., Pulp and Paper Division in Crofton.

RÉSUMÉ

Nagtegaal, D. A., J. Candy and B. Riddell. 1994. A preliminary report on the chinook productivity study conducted on the Cowichan River during 1990 and 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2265: 71 p.

En 1990 et 1991, la Direction des sciences biologiques de la Station de biologie du Pacifique a mené une étude sur la productivité du saumon quinnat (*Oncorhynchus tshawytscha*) dans la rivière Cowichan. Elle comportait les principaux éléments suivants: i) dénonmbrement des géniteurs, ii) estimation des captures de subsistance des Autochtones, iii) enregistrement des prélèvements de géniteurs pour les élevages, iv) échantillonnage biologique et collecte de données sur les micromarques codées. En 1991, une étude sur le marquage avec recapture a aussi été réalisée afin d'augmenter l'effectif dénombré aux barrières. On a estimé que le nombre total de quinnats adultes qui revenaient dans la Cowichan s'élevait á 5 094 poissons en 1990, et á 5 065 en 1991. Ces chiffres sont considérés comme des estimations minimales étant donné que, pour ces deux années, la barrière de dénombrement a été emportée par le haut niveau de l'eau avant la fin de la remonte. Selon les agents des pêches, les remontes de quinnats adultes en 1990 auraient été de 5 300 et de 10 000 en 1991. De plus, un plan de gestion de l'eau a été mis en oeuvre par la Direction des pêches du ministère des Pêches et des Océans en collaboration avec le ministère de l'Environnement, des Terres et des Parcs et Fletcher Challenge Canada Ltd, Division des pâtes et papiers, á Crofton.

INTRODUCTION

Considerable interest has been focused towards the chinook salmon (*Oncorhynchus tshawytscha*) stocks in the southern portion of the Strait of Georgia over the past several years due to the perceived decline in these stocks and their importance to the local fisheries. The Biological Sciences Branch, Pacific Biological Station, initiated a study of chinook productivity to assess rebuilding strategies and to evaluate the effects of harvest management policies for these stocks. In the fall of 1988, a study was implemented on the Cowichan River with additional information collected from the Squamish and Nanaimo River systems. The objectives of this study include: i) quantitatively determining the optimum spawning requirement for chinook salmon in the Cowichan River (this involved investigations of the determinants of juvenile production, interactions between hatchery and wild chinook, and estimation of the spawning escapement and catch attributed to the hatchery and wild components of the total run), and ii) development of guidelines for establishing escapement targets for other B. C. chinook stocks.

Hatchery production of chinook on the Cowichan River began in 1980 (Cross et. al.,1991). Total chinook fry releases have increased from 64,681 in 1980 to 665,901 in 1991 (Millerd, pers comm). Marked releases began in 1980, and in 1991 approximately 44% of the total number of chinook released were coded-wire tagged.

As an adjunct to this study a water management plan, which was also implemented in 1988 (KPA Engineering Ltd. 1991), was maintained on the Cowichan River by the Fisheries Branch. The rationale behind this plan was to increase water flow for a short period (5-10 days) during the early part of the chinook run. This was intended to aid upstream movement of chinook. These fish may otherwise be obstructed in their upstream migration and suffer pre-spawn mortalities due to typically low water levels in the Fall.

The purpose of this report is to present the results of the productivity study conducted on the Cowichan River during the fall of 1990 and 1991.

METHODS

Components of the Cowichan River study (Fig. 1) include: i) enumeration of spawning chinook salmon; ii) estimation of native food fishery catch; iii) recording of hatchery broodstock removals; and iv) collection of biological data and sampling of coded-wire tag (CWT) recoveries.

A detailed description of the methodology used to collect the above information was presented in Nagtegaal et al. (1994). Changes made in 1990/91 to the methods used are described below.

CONSTRUCTION OF COUNTING FENCE:

In 1990, a resistance-board weir was installed in the Cowichan River. This type of weir was a modification of a bamboo system initially designed by the Japanese (Bartlett, unpubl). The weir was designed in such a way that it could adjust to changes in water depth and flow and also be able to temporarily sink below the water level to allow debris to pass over.

The weir was made of a series of 1.2 m (4 ft) wide panels connected together to form a picket fence structure that spanned the width of the river (Fig.2). Each panel was constructed of sixteen 3.6 m (12 ft) lengths of 3.2 cm (1 1/4 in) Schedule 40 ABS pipe that were fastened to the same diameter ABS pipe cross braces using galvanized pipe clamps. The ABS pipes were spaced 3.2 cm (1 1/4 in) apart and cross braces were placed every .6 m (2 ft) along the length of the panel. Wood cross braces (5 cm x 7.6 cm fir) were used to reinforce the base of each panel and where the resistance boards were attached to the panel. All connections were bolted together using nylok nuts. Aluminum couplings were fabricated to connect panels together and allow for lateral movement of the fence. Since each panel was a separate unit, it would be possible to individually remove and replace them if damage occurred.

The resistance boards were made of a 121.9 cm (48 in) by 30.5 cm (12 in) styrofoam sheet (thickness: 2.5 cm) laminated on either side with 0.6 cm (1/4 in) plywood and bolted together. The plywood and the edges of the styrofoam were painted with a marine enamel. The resistance board was connected to the cross brace on the panel with heavy duty galvanized hinges. The other side of the board was then fastened to the panel using turnbuckles and 0.3 cm (1/8 in) wire cable. This configuration allowed the resistance-boards to be adjusted to the correct angle required to maintain bouyancy.

Panels were secured to the river bed using steel rail. Six 4.9 m (16 ft) lengths of 122.4 kg/m (90 lb/ft) railroad rail were placed on the riverbed and fastened together with railway connectors. Sections of chainlink fence were fastened to either side of the rail and buried in the gravel bed of the river to provide stability and prevent fish from digging under the weir. The rail was laid in the river bed perpendicular to the water flow. Steel eyes were welded to the top of the rail at 40 cm (16 in) intervals. At the base of each panel three open-jawed turnbuckles were fastened to the wooden cross brace. The panels were fastened to the rail by threading a 0.47 cm (3/16 in) galvanized cable through the eyes on the rail and the turnbuckles on the panel. This cable was clamped to the rail at one end and wound up on a hand winch on the other end to allow for adjustments to the tension.

The panels were butted up against a fish trap on one side of the river and against a wood abutment on the other. The abutment was constructed from 5 cm x 15 cm (2"x 6") fir boards and anchored into the river bank. It was built perpendicular to the

rail forming a squared edge to the river bank. Fine mesh netting was lashed between the last panel and the abutment so that no fish could pass by.

The fish trap, which was built in 1989, was modified to make it operational for the present setup. An adjustable white flashboard was placed at the base inside the fish trap so fish could readily be counted. The flashboard could be lowered and raised with hand winches to the desired level according to the depth of the water in the trap, in order to maintain optimal visibility of the fish passing through. Steel grates were fastened to the upstream and downstream side of the flashboard with galvanized hinges so that when it was raised, water could easily flow underneath the board. A set of aluminum gates were built into the fish trap and put in place to trap fish for broodstock and tagging purposes or removed to allow fish to pass freely through the trap. In addition, the hatchery staff built two holding pens adjacent to the trap so chinook caught in the trap could be held for transportation to the hatchery.

A counting tower was constructed adjacent to and overlooking the fish trap. This tower was approximately 3.6 m (12 ft) in height and was equipped with 500 watt halogen floodlights. Observers could readily monitor the fish passing through the trap as well as having a clear view of the entire weir structure.

In 1991, a few modifications were made to the weir to increase the effectiveness of the operation. The 3.6 m (12 ft) ABS pipes were replaced with 6 m (20 ft) lengths. This decreased the angle of the panel relative to the flow of water and was intended to make it easier to keep the fence clean of debris. The resistance boards were enlarged to 122 cm by 61 cm (48" x 24") to provide more bouyancy. All pipe clamps were replaced with 3.8 cm (1.5") stainless steel hose clamps since leaves and other debris tended to get hung up on the clamps. The clamps could be fastened tightly on the ABS pipe preventing cross members from slipping along the pipe.

The counting fence was placed in the same location as in previous years (Fig.1).

FENCE OPERATION:

In 1990, the counting fence was operational from September 12 through to the end of the survey (Oct.25). Counts were recorded by fifteen minute intervals for adult and jack chinook, adult and jack coho and chum. If identification was in doubt those fish were recorded in the unknown category. In addition water depth, water temperature, water clarity, and weather were recorded four times per day. On a daily basis the fence was cleaned of leaves and other debris. Records of fish collected at the fence by the hatchery staff were also kept.

In 1991, the operation began earlier than in previous years so that we could gain an understanding of the early part of the chinook run. The fence was put in place by Aug. 19 and was taken out of the river on Nov. 12. However, due to extremely high water flows during the first part of September, the fence sank under water on Sept. 1 and did not become operational again until Sept. 11. Counting procedures remained the same as in previous years.

SWIM SURVEY:

Four swim surveys were made by Fishery Officers during 1990 to estimate the spawning population of chinook. These were conducted on Aug. 23, Sept. 14 and 27, and on Oct. 19. In 1991, swim surveys were conducted on Sept. 19, Oct. 2, 17, and 31. Each survey was conducted by three experienced swimmers and one person in a canoe who recorded the data. Each swimmer (one in the middle and one on each side of the river) counted the fish seen within their range of visibility. The three swimmers attempted to keep abreast as they approached each pool while the person in the canoe lagged behind within hailing distance. Counts were recorded by pool/riffle and then compiled by river section. To maintain consistency generally the same swim team was used for each survey during the spawning season.

It was intended that the swim survey estimates remain independent of the fence count. Even though no data from the fence count were passed on to Fishery officers during the course of the season, general trends in escapement numbers were known.

NATIVE FOOD FISHERY:

In 1990, a systematic approach was developed by the Cowichan Band to estimate the native food fish catch as well as manage the fishery more closely (Paige, Unpubl.). This approach involved the recording of catch and effort by management zone within the native fishing boundaries (Fig.3). A crew of four observers patrolled the fishery on a daily basis and interviewed fishermen for numbers caught by area and total time spent fishing. In this way, weekly estimates of catch per unit effort were obtained. CPUE was adjusted for daily changes in fishing effort and differences in effort among fishing zones. These data were then extrapolated over time and area to estimate total catch by week.

BIOLOGICAL DATA:

Biological data for chinook were to be collected from four sources: i) hatchery broodstock samples; ii) enumeration fence; iii) mark/recapture program (1991 only); and iv) native food fishery. Hatchery staff collected biological data and recorded the incidence of CWT tagged chinook used for broodstock. A random

sample of chinook going through the trap were sampled for length, sex, scale, and checked for missing adipose fin from the beginning, middle and end of the run. The goal was to sample 30% of the chinook run.

A member of the Cowichan Indian Band was hired to collect biological data from the Native food fishery for chinook. The person monitored both the traditional spear fishery as well as the in-river gillnet fishery. Data for length, sex, and adipose clip rate were recorded by management zone on a daily basis. The person interviewed as many fishermen as possible and attempted to sample fish from all management zones. Due to concentrated fishing effort in certain zones and lack of cooperation from some fishermen, not all areas were sampled equally.

MARK-RECAPTURE:

A mark/recapture program was implemented in 1991 which involved the tagging of chinook jacks and adults at the enumeration fence and subsequent recovery on the spawning grounds. This was intended to provide an independent estimate of escapement to augment the fence count. Chinook were individually dipnetted out of the fish trap, tagged with a Ketchum[1] aluminum sheep ear tag on the operculum, and immediately released. Fish were placed in a quiet pool just above the trap to allow for recovery. Essentially all fish tagged were in good condition at release since those fish that were considered to be in rough shape were not tagged. Length, sex, and adipose clip information was recorded for all tagged fish.

A two man crew in an inflatable boat surveyed the upper section of the river (Fig. 1) on a daily basis and collected all spawned chinook carcasses. This section of the river above Skutz Falls represents the area where the majority of spawning occurs. On a weekly basis the middle section of the river (Skutz Falls to the fence) was also surveyed for carcasses. A 4.2 m (14 ft) pole with a gaff hook attached to the end was used to recover carcasses. Carcasses were likely missed if they ended up in pools too deep to sample. For each fish sampled the location, length, sex, and presence/absence of the adipose fin was recorded and the tail cut off to prevent recounting.

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[1]Ketchum Manufacturing Ltd., Ottawa, Canada.

RESULTS

ENUMERATION FENCE:

Daily counts at the enumeration fence are contained in Table 1, Fig. 4 (1990) and Table 2, Fig. 5 (1991). In 1990, daily counts were recorded from Sept. 12 to Oct. 25 when the counting fence was submerged due to high water. Total counts recorded during this period were: 4164 adult chinook; 15,199 jack chinook; 18,636 adult coho; 2847 jack coho; 318 chum and 361 unknown salmon.

In 1991, daily counts were recorded from Aug. 19 to Nov. 11, although the fence was not functional from Aug. 31 to Sept. 9 due to unusually high water levels. Flow rates during this time reached a high of 87.2 cu.m./sec when the mean flow rate for this period over the last 20 years was only 9.7 cu.m/sec (Fig. 6). The project was started earlier this year because we wanted to gain a better understanding of the early part of the run. Total counts recorded during this period were: 2375 adult chinook; 1626 jack chinook; 6138 adult coho; 1673 jack coho; 2057 chum and 18 unknown salmon.

During the course of the season, jacks tended to enter the river a bit earlier than adult chinook. Daily counts were summarized by one hour intervals (Tables 3 and 4) and we note that peak movement of chinook occurred between 0700 and 0900 in the morning and between 1600 and 1800 in the evening.

During several shifts throughout the migration period an independent count was made at the enumeration fence to determine the accuracy of the counting procedure and species identification. No errors were recorded.

SWIM SURVEYS:

A summary of swim surveys from 1981-1991 is presented in Table 5. Total escapement estimates for each year are for adult chinook only. The 1990 escapement of adult chinook was estimated by Fishery Officers to be 5300 based on the four swims made during the season. All swim surveys were conducted under good conditions and no major difficulties were encountered. Since the flow rate increased substantially towards the end of October no survey could be made in November. It was assumed that the final swim on Oct. 19 was made during peak spawning.

The 1991 escapement of adult chinook was estimated by Fishery Officers to be 10,000. Again all swims were conducted under good conditions. During winter flooding in 1990 a 2.5 mi. stretch of the river (Fig. 1) changed course and formed a secondary channel which became isolated from the main flow. Due to log jams and other debris the main flow section became too hazardous for the swimmers. As a result this section of the river, which in previous years was part of the standard survey, could not be observed during the swim survey in 1991. Only a short section of the secondary

channel was monitored since few fish utilized this channel. It was again assumed that the final swim on Oct. 31 was made during peak spawning.

Because the flow rate during 1991 was unseasonably high in the beginning of September the adult count from the first swim survey was extrapolated using a different 'expansion factor' than in previous years (T. Fields, pers. comm). According to Fields, the first swim survey count in September has usually been expanded by a factor of 4.8, but since it was assumed that the high water caused all the chinook to migrate to the upper end of the river, the count of 1882 adults on Sept. 19 was only expanded by a factor of 3.2. The first swim survey count was considerably higher than any other first count during the last ten years (Table 5). It was assumed that large numbers of chinook migrated upstream during the high water when the fence was not in operation.

NATIVE FOOD FISHERY:

Estimates of the native food fish catch of chinook for 1990 and 1991 are listed in Table 6. These estimates are determined by the River Management Unit of the Cowichan Indian Band. During both years there were some difficulties experienced in calculating catch estimates but it was felt that the methodology used to determine total catch was improving and that these estimates were considered more accurate than in previous years (Wayne Paige, pers comm.). The total adult chinook catch estimate in 1991 was one of the lowest in recent years (270), presumably due to the unusually high water during peak fishing times.

HATCHERY COMPONENT:

In 1990, all the chinook needed for broodstock (327) were collected by the Cowichan River hatchery staff at the enumeration fence (Table 7). In 1991, a total of 2039 chinook were removed from the river for broodstock, of which 53% were collected at the enumeration fence (Tables 8 and 9). After broodstock activities were completed in 1991, 284 males were returned to the river by the hatchery staff. A summary of broodstock collection for 1981-1991 is contained in Table 10. Note that primarily 3 and 4 year old chinook were used for broodstock (Table 11).

BIOLOGICAL DATA:

During 1990 a total of 715 adult and 1346 jack chinook were sampled at the enumeration fence site for adipose marks. A total of 665 adults and 626 jacks were sampled at the counting fence during 1991. The mark rate in 1991 (6.6%) for adults only (sexes combined) was double the rate in 1990 (3.5%) (Table 12).

Although a limited number of fish were sampled from the Indian food fishery, the mark rate in 1991 (4.6%) was also more that double the rate in 1990 (0.9%) (Tables 13 and 14). In both years the majority of the chinook taken in the food fishery were 3

and 4 year olds (Table 15). In 1990, twice as many female chinook were caught than males, but the reverse was true for 1991.

Length-frequency summaries of chinook broodstock collected and sampled at the hatchery are listed in Table 16 (1990) and Table 17 (1991). In 1990, the adipose clip rate was 10.3% for males, only one clipped jack chinook was sampled, and 0.4% of the females were marked. In 1991, the adipose clip mark rate was 18.7% for males, 90.4% for jacks, and 20.8% for females.

In 1990 no chinook were sampled on the spawning grounds due to high water. Table 18 lists the size frequency of chinook tagged in 1991 at the counting fence. Table 19 contains a length-frequency summary of chinook sampled on the spawning grounds in 1991. The adipose clip mark rate for males was 5.5% and for females was 7.6%. The majority of chinook sampled on the spawning grounds were 3 and 4 year olds (Table 20). Slightly more adult females (54%) were recovered than males.

WATER RELEASE STUDY:

In 1990, additional water was released from storage on September 22 and on Oct. 3, and in 1991 on Oct. 4. Water flow and water depth were monitored at the counting fence (Table 21,1990; Table 22,1991) and at the Water Survey Canada recording station at the Island highway in Duncan (Table 23,1990; Table 24,1991). Note that with each water release a corresponding increase in the daily chinook count occurred in 1990 (Fig 7) and 1991 (Fig 8). The weather was rainy when additional water was released on Oct. 3 in 1990. During the first water release in 1990 and the release in 1991 the weather was clear and sunny.

MARK-RECAPTURE:

Table 25 summarizes the tagging data for chinook at the fence and Table 26 lists the recovery data for chinook sampled on the spawning grounds. Both tagging (Sept.17-Nov.6) and recovery (Oct.24-Nov.12) was spread over several weeks during peak migration and spawning. In 1991, 616 adult and 650 jack chinook were tagged. Only 7 tagged males and 8 tagged female chinook were recovered out of 1058 sampled on the spawning grounds. Approximately one-third (33%) of the tagged fish recovered had lost the tag but had an obvious mark on the operculum indicating that a tag had been applied.

Only one tagged jack chinook was recovered on the fence that had presumably died from tagging. Initial mortality due to the tagging procedure must have been be low otherwise more tagged chinook would have ended up dead on the enumeration fence. The only measure of longer term mortality was the number of tagged pre-spawn mortalities recovered on the spawning grounds. Only one tagged female chinook was recovered on the spawning grounds in the upper section of the river that had died before it spawned.

DISCUSSION

ENUMERATION FENCE:

Enumeration data could only be collected for the time the fence is in full operation. Although this was the period during which most chinook were presumed to enter the river we have limited information regarding the numbers that entered before or after the fence was in operation. In 1990, only one swim survey was available to estimate the chinook in the river prior to Sept. 12, and no information was available about how many fish may have entered the river after the fence was washed out on Oct. 25. Our data suggests that the run was not completely over but had certainly slowed since fewer numbers of chinook were passing by the fence during the last days of operation. In 1991, the fence was removed (Nov. 11) when the chinook run was almost complete and was in operation on Aug. 19 when no appreciable numbers of chinook were moving upstream. Due to extremely high water conditions we were unable to monitor fish movement from Aug. 31 to Sept. 9. Both 1990 and 1991 fence counts must, therefore, be considered an incomplete count of the total run.

SWIM SURVEY DATA:

The error associated with actual swim counts (problems caused by water clarity, duplicate counting, missed fish, species identification errors) and extrapolating procedures used are difficult to assess. In the Big Qualicum River, Shardlow et al. (1987) estimated that the probability of seeing a chinook in a swim survey was 63%. Observer efficiency ranged from 50% to 64% in studies conducted on the Lardeau River under similar conditions (Northcote and Wilkie 1963). On average, 87% of adult coho present in a survey conducted on the Trent River were observed during snorkel surveys (Bocking et al. in press). Among the biases typically associated with swim surveys, the procedure used by Fishery Officers to extrapolate actual swim counts to total estimates warrants some consideration (Burns,Unpubl). Assumptions concerning the distribution of chinook in the river at the time of the survey are the basis for expanding these counts to estimate total escapement. A comparison of the last swim survey count (adults only) and the final escapement estimate (Fig. 9) indicated that the relationship between these two values has been fairly consistent over the past ten years. Some problems were experienced during extremely low water flow conditions in 1986 and 1987.

The escapement estimate based on swim survey results may have been too high for the following reasons. In previous years, the first swim count was generally expanded by a factor of 4.6 (1981-1990 mean) based on the assumption that early in the fall the fish are distributed throughout the river (Fields, pers comm.).

The last swim count was generally expanded by a factor less than 4.6 (1981-1990 mean was 2.6) assuming that by this time most of the fish have moved into the upper section of the river. In 1991, the extrapolation factor (3.2) used for the first swim count may have been too high and did not properly reflect these assumptions. Secondly, the first swim count (Sept. 19) recorded 1882 chinook adults in the upper portion of the river while at the same time only 142 adults and 180 jacks had passed by the fence. This suggests that approximately 1500 to 2000 adults may have passed by the fence during the period of high water. This difference was noted for each subsequent swim count and corresponding fence count. However, the final escapement expanded from the swim data was much higher than the sum of the fence count and the 1500-2000 fish that may have passed by during the period of high water. Thirdly, in 1981 the final swim survey was conducted on Oct. 23 and the count of 3200 adults was expanded to 5500. If we compare this to the final swim count in 1991 of 3502 (of which 516 were carcasses) which was expanded to 10,000 adult chinook, we note a significant difference in the expansion factor used.

NATIVE FOOD FISHERY:

Since we do not have the opportunity to directly assess the catch estimation technique used, no comments could be made regarding the methodologies used. The 1990 catch estimate of 604 seemed to be a reasonable value based on previous year's data and our observer sampling information. Based on the observer sampling data from the native food fishery in 1991, the adult catch estimate of 270 seems low. The observer sampled 109 chinook and estimated that he had monitored approximately 20% of the total catch (Jed August, pers. comm.). On this basis, we estimated the actual food fish catch to be closer to 550 adults. From the sampling data it was noted that primarily 3 and 4 year old fish are caught in the fishery.

BIOLOGICAL DATA:

In 1991, significant differences were noted between the chinook biosample data collected by the hatchery staff and the data collected by our field staff. The incidence of adipose clipped fish in the chinook sampled at the fence was similar ($P > 0.05$, chi-square) to the mark rate of fish sampled on the spawning ground, but significantly different ($P < 0.05$, chi-square) than the broodstock mark rate recorded at the hatchery. Cumulative frequency distributions (Zar, 1984) were compared by sex between hatchery, fence, and spawning ground samples for adult chinook. No significant differences ($D_{obs} < D_{alpha}$; Kolmogorov-Smirnov test) were detected between these three samples. Although a similar size range of chinook were sampled by the hatchery and the field staff, considerably greater numbers of marked fish were sampled by the hatchery staff. One reason for these differences may be that the mark rate of fish taken at the fence was markedly different from

those fish collected for broodstock in the river below the fence. Since the hatchery staff did not record the incidence of adipose marks by area collected, this avenue could not be pursued. Another possibility might be that a greater proportion of returning chinook from the early hatchery release group (chinook fry released in the lower river in April) were removed for broodstock below the fence. The early release group has been marked at a much higher rate (98%-100%) than other release groups (Table 27) over the past few years, and this group has been released in the lower part of the river below the fence. Examination of the CWT data from spawning ground sampling (Table 28) indicated that 54% of the fish recovered in the lower part of the river (section 11-13, see Fig. 1) were from the early release group. However given the limitation to the sampling of the lower river collections, no definite conclusions could be made concerning this discrepancy.

WATER RELEASE STUDY:

Weather conditions, water temperature and flow rate all affect the timing of migration of spawning salmon. A cursory look at the enumeration data suggests that the release of stored lake water contributed to the upstream movement of chinook. The 1990 results were positive since considerable increases in movement were recorded during both water releases. The effect of the increased water flow in 1991 may have been reduced since the water had been unusually high for some time prior to the release. To what extent the weather conditions contributed to the effect of the water release on upstream movement is unknown.

MARK-RECAPTURE:

Recovery of tagged fish on the spawning ground posed a considerable problem on the Cowichan River. The main spawning area in the upper section of the river consists of a series of riffles and deep pools. When the flow rate is less than 750 CFS, carcasses can quite easily be recovered, but when flows are higher (which typically occurs at peak spawning due to fall rains) the water becomes muddy and the carcasses tend to disappear into the deep pools. Even though a fairly extensive carcass recovery program was implemented and weather/water flow conditions were good, very few tagged chinook were recovered.

Due to the small number of tags recovered no Petersen estimates were calculated. Possible reasons for the poor recovery rate could be tag loss, and/or a high rate of tagging mortality. If tag loss was the primary cause, we should have observed considerably higher numbers of fish on the spawning grounds that had an obvious notch in the operculum indicating where a tag used to be. For future studies a secondary tag should be applied to make it possible to further investigate tag loss. If high tag related mortality was the cause then we should have observed more tagged mortalities at the fence and more pre-spawning mortalities on the spawning grounds. Neither of these situations occurred. In

a chinook hooking mortality study, Wertheimer et al. (1989) observed that delayed mortality was the highest in fish that sustained injuries to the gills (65%). We observed that the aluminum tag caused some abrasion to the gills. Several of the tagged carcasses examined on the spawning grounds had sustained some damage to the gills, but there was no indication that this was the cause of death.

It is worthwhile to note that the mark rate of fish recovered (Tables 29 and 30) from the middle section of the river (6.3%) was nine times higher than for those recovered in the upper section of the river (.7%). It may be that the stress associated with the tagging procedure was not great enough to cause death in the short term but sufficient to impede movement upstream.

Since so few tagged fish were recovered no conclusions regarding tag loss or tag related mortality could be made. More study is required to further investigate these problems.

SEAL PREDATION:

Although seal predation was not directly assessed in this study, it is worthwhile to examine the impact seals have on chinook in Cowichan Bay. In 1988, the number of seals gradually increased from a low of 30 in April to a peak of about 100 in December. According to Olesiuk et al. (1990) harbour seals consume an estimated 9 tonnes of salmon annually in Cowichan Bay. An estimated 23% (Sept.) to 48% (Nov.) of the harbour seal's diet in Cowichan Bay was comprised of salmon. Based on these data, consumption of chinook salmon could range from 500 to 1500 adults. This data was collected in 1988 when low flows in the Cowichan River persisted until the end of October. Predation likely increases the longer chinook salmon remain in the estuary waiting for high water to move upstream.

ESCAPEMENT ESTIMATE:

Total return of adult chinook to the Cowichan River was determined to be equal to the sum of the fence count, the numbers removed for broodstock below the fence, and the amount of fish taken by the Indian food fishery. On this basis we calculate the total return of adult chinook to the Cowichan River from Sept. 12 - Oct. 25, 1990 to be 4768 (Table 31). This is a minimum estimate since these numbers are based on the fence count and assumes that no chinook were in the river prior to or after the counting fence was in place. According to the swim survey estimates there may have been 250 to 1000 adults in the river prior to the construction of the counting fence. Since the fence was washed out prior to the end of the run, we estimate 500 to 1000 chinook may have entered the river after the fence operation was terminated. The Fishery officer's estimate for adult chinook based on swim surveys (5300) was slightly more than the fence count (4164). It is probable that the total return of chinook in 1990 was closer to 6000 adults. The number of natural spawners was calculated to be 3838 (Table 31).

This was based on the fence count minus the chinook adults removed for broodstock above the fence.

In 1991, we calculated the total return of adult chinook to the Cowichan River from Aug. 19 - Nov. 11 to be 5345 based on the available data (Table 31). Except for the short period when the counting was discontinued due to high water, the fence operation encompassed close to the entire chinook run. This estimate included 550 adult chinook taken in the food fishery and 2000 chinook that may have migrated upstream during the time the fence was not in operation in early September. The Fishery officer's estimate for adult chinook based on swim surveys (10,000) was slightly less than twice our estimate. Even if we doubled the number of chinook that may have migrated upstream during the time the fence was not in operation, the total return would still be considerably less than the Fishery officer estimate. For reasons stated earlier, we believe that the calculated total return of 5345 adults is a reasonable estimate given the available information. The number of natural spawners was calculated to be 3200 (Table 31). This was based on the fence count minus the chinook adults removed for broodstock above the fence.

It should be emphasized that the calculated total returns of adult chinook for 1990 and 1991 be considered as minimum estimates.

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Table 1. Daily counts at the enumeration fence site, 1990

	Date	Chinook		Coho		Chum	Unknown[1]
		Adult	Jack	Adult	Jack		
Sept.	12	0	10	0	0	0	0
	13	1	45	0	0	0	0
	14	8	346	0	0	0	0
	15	10	328	0	0	0	0
	16	3	168	0	0	0	0
	17	10	132	0	0	0	0
	18	135	2095	0	1	0	1
	19	40	388	1	0	0	0
	20	8	69	1	3	0	3
	21	7	156	2	2	0	1
	22	32	576	3	1	0	0
	23	130	2295	2	2	0	0
	24	115	840	10	3	0	0
	25	536	1094	26	16	0	0
	26	265	531	31	6	0	0
	27	236	661	12	2	0	0
	28	16	52	6	3	0	0
	29	96	443	7	3	0	0
	30	32	176	2	0	0	0
Oct.	01	90	327	3	1	0	0
	02	5	20	5	7	0	0
	03	7	44	9	3	1	0
	04	634	1940	387	105	2	5
	05	375	268	678	45	0	284
	06	201	204	134	69	1	16
	07	217	454	530	115	0	0
	08	200	325	436	45	0	0
	09	68	89	880	38	1	0
	10	49	84	679	61	5	0
	11	22	25	564	145	0	1
	12	37	33	715	301	0	1
	13	11	64	200	65	0	3
	14	38	46	324	133	0	6
	15	91	170	1131	148	0	12
	16	31	51	696	67	3	0
	17	28	55	305	34	1	0
	18	47	20	1448	480	2	15
	19	40	83	2084	149	6	0
	20	20	22	421	61	1	0
	21	179	259	4406	608	225	13
	22	28	108	1327	48	28	0
	23	32	64	676	45	20	0
	24	11	34	137	20	5	0
	25	23	5	358	12	17	0
	Total:	4164	15199	18636	2847	318	361

[1] Unidentified salmon

Table 2. Daily counts recorded at the enumeration fence, 1991

	Date	Chinook		Coho		Chum	Unknown[1]
		Adult	Jack	Adult	Jack		
Aug.	19	0	0	0	0	0	0
	20	0	0	0	0	0	0
	21	0	1	0	0	0	0
	22	0	0	0	0	0	0
	24	0	0	0	0	0	0
	25	0	0	0	0	0	0
	26	1	1	0	0	0	0
	27	0	1	0	0	0	0
	28	14	7	0	0	0	0
	29	6	5	0	0	0	0
	30	0	0	0	0	0	5
Sept.	10	4	3	0	0	0	2
	12	4	0	0	0	0	0
	13	8	2	0	0	0	0
	14	17	9	0	0	0	0
	15	4	2	0	0	0	0
	16	21	31	0	0	0	0
	17	34	62	0	0	0	0
	18	21	36	0	1	0	0
	19	8	20	0	0	0	0
	20	7	10	1	0	0	0
	21	8	11	0	0	0	0
	22	1	2	3	0	0	0
	23	10	13	5	9	0	0
	24	3	15	8	11	0	0
	25	10	15	4	11	0	0
	26	64	120	30	2	0	0
	27	43	143	39	50	0	0
	28	12	8	12	6	0	1
	29	16	11	9	7	0	0
	30	53	22	11	6	0	2
Oct.	01	29	12	8	8	0	1
	02	64	29	21	23	0	0
	03	66	22	29	13	0	0
	04	23	19	21	8	0	1
	05	89	71	67	17	0	1
	06	63	43	31	13	0	0
	07	17	17	44	19	0	0
	08	265	142	211	149	0	0
	09	75	14	95	48	0	0
	10	31	14	54	12	0	0
	11	26	8	21	11	0	0
	12	29	12	38	15	0	0
	13	52	6	45	13	0	0
	14	25	9	37	12	1	0
	15	37	13	45	10	1	0
	16	137	52	189	90	1	1
	17	54	11	189	55	1	0
	18	46	11	49	9	3	0
	19	46	10	34	15	0	0
	20	23	6	60	12	0	1
	21	45	16	113	35	0	0
	22	21	2	31	2	1	1
	23	29	8	66	23	4	2
	24	50	29	169	78	13	0
	25	52	26	122	65	1	0
	26	20	15	27	6	2	0
	27	14	4	45	9	2	0
	28	20	29	18	11	5	0
	29	14	10	18	4	1	0
	30	57	35	49	21	16	0
	31	41	49	117	49	33	0
Nov.	01	82	62	229	48	24	0
	02	50	32	150	17	32	0
	03	29	14	35	10	31	0
	04	39	26	135	49	134	0

Table 2 (cont.)

Date		Chinook		Coho		Chum	Unknown[1]
		Adult	Jack	Adult	Jack		
Nov.	05	95	59	1307	210	56	0
	06	73	31	752	94	67	0
	07	10	14	93	31	30	0
	08	21	32	505	93	119	0
	09	19	11	295	30	304	0
	10	7	11	119	49	308	0
	11	21	40	333	84	867	0
TOTAL:		2375	1626	6138	1673	2057	18

[1]Unidentified salmon

Table 3. Daily counts by time interval, 1990

Time	Chinook Adult No.	%	Jack No.	%
0000-0100	160	4	918	6
0100-0200	160	4	1073	7
0200-0300	115	3	853	6
0300-0400	105	2	667	4
0400-0500	103	2	678	4
0500-0600	154	4	1099	7
0600-0700	144	3	584	4
0700-0800	432	10	1141	7
0800-0900	410	9	1822	12
0900-1000	365	8	684	4
1000-1100	128	3	283	2
1100-1200	80	2	148	1
1200-1300	107	2	192	1
1300-1400	103	2	195	1
1400-1500	138	3	372	2
1500-1600	181	4	434	3
1600-1700	562	13	1074	7
1700-1800	392	9	1066	7
1800-1900	148	3	593	4
1900-2000	65	2	183	1
2000-2100	48	1	144	1
2100-2200	45	1	162	1
2200-2300	58	1	600	4
2300-2400	114	3	291	2

Table 4. Daily counts by time interval, 1991

Time	Chinook Adult No.	%	Jack No.	%
0000-0100	68	3	116	7
0100-0200	88	4	37	2
0200-0300	75	3	76	5
0300-0400	77	3	78	5
0400-0500	70	3	77	5
0500-0600	98	4	62	4
0600-0700	117	5	71	4
0700-0800	115	5	65	4
0800-0900	162	7	75	5
0900-1000	89	4	69	4
1000-1100	67	3	36	2
1100-1200	82	3	38	2
1200-1300	39	2	42	3
1300-1400	42	2	40	2
1400-1500	81	3	45	3
1500-1600	109	5	56	3
1600-1700	213	9	116	7
1700-1800	192	8	174	11
1800-1900	165	7	124	8
1900-2000	98	4	55	3
2000-2100	96	4	47	3
2100-2200	79	3	55	3
2200-2300	81	3	40	2
2300-2400	72	3	55	3

Table 5. Swim survey data collected for the Cowichan River by fishery officers stationed in the Duncan subdistrict.

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1981	S	Sept. 12	175		208	1000	2-4
	S	Oct. 2	103		93	1500	2-4
	S	14	364		1160	4000	2-4
	H	22			2000		1-7
	S	23			3200	5000	2-4
Total for Season[3]						5500	
1982	S	Sept. 14	199		131	600	2-4
	S	Oct. 13			153		2-4
	H	19	saw few fish on spawning grounds				1-13
	F	Nov. 8				4000	
Total for Season						4500	
1983	S	Sept. 8	38		61	254	2-6
	S	15	62		121	504	2-6
	S	28	190		470	1838	1-2
	S	Oct. 7	207		425	1804	2-6
	S	14	802		997	2836	2-7
	S	25	901		1113	4500	1-6
Total for Season						4500	
1984	S	Aug. 28	80		84	400	2-5
	S	Sept. 6	25		72		
	S	13	79		80		3-11
	S	19	35		71		2-6
	S	26	291		434		2-6
	S	Oct. 3	205		283		3-7
	S	"	206		282	2200	8-11
	S	23	525		1300	5000	1-6
	S	Nov. 1	350		1276		1-6
Total for Season						5000	
1985	S	Sept. 12	39		46	220	2-6
	S	17	42		10		12-13
	S	18	210		33		2-6
	S	27	245		104	456	2-6
	S	Oct. 3	244		99	360	2-6
	S	10	285		219		2-6
	S	16	293		347		2-6
	S	31	229		934	3500	1-6
Total for Season						3500	

Table 5. (cont.)

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1986	S	Sept. 9	295		85	300	2-6
	S	18	46		29	300	3-6
	S	24	161		56	350	12-13
	S	Oct. 7	1310		223	1000	2-6
	S	29	613		473	1200	1-6
	S	Nov. 6	1178		491	1200	
	H	8			515		1-13
Total for Season						1200	
1987	S	Sept. 9	30	300	10	50	3-8
	S	17	111		16	75	2-6
	S	25	112		16	75	3-6, 11-12
	S	Oct. 6	196	800	115	400	2-6
	S	15	196		96		1-6
	H	16		saw very few spawners			1-13
	S	28	417		468		1-6
	S	Nov. 6	329		649		1-6
Total for Season						1200	
1988	S	Aug. 25	100		50		2-6
	S	Sept. 1	271		149	700	2-6
	S	23	1464		271	1000	2-6
	S	Oct. 3	821	1600	1094	3500	2-6
	S	14	2008		2076	4000	1-6
Total for Season						5500	
1989	S	Sept. 11	151		58	300	2-6
	S	21	95		39	350	3-6
	S	Oct. 5	95		48	700	2-3
	S	18	719		350	1200	2-6
	S	Nov. 1	1537		2267		2-6
Total for Season						5000	
1990	S	Aug. 29	254		54	250	2-6
	S	Sept. 14	385		89	1000	3-6
	S	27	3169		477	2200	2-3
	S	Oct. 19	4297		2382	5000	2-6
Total for Season						5300	

Table 5. (cont.)

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1991	S	Sept. 19			1882	6000	2-6
	S	Oct. 2			2873	7500	2-6
	S	17			2924	8700	2-6
	S	31			3502[4]	9000	2-6
Total for Season						10000	

[1]S - Swim survey, H - Helicopter survey, F - boat survey
[2]Refer to Fig. 1
[3]Total escapement estimate for adult chinook
[4]516 chinook carcasses were counted in this total

Table 6. Indian food fish catch estimates for the Cowichan River.[1]

Year[2]	Adult Chinook	Jack Chinook
1981	1500	1500
1982	1000	1000
1983	250	1000
1984	355	700
1985	1000	1000
1986	800	800
1987	800	800
1988	681	450
1989	1055	250
1990	604	214
1991	270	100

[1]Includes legally caught chinook from the native spear fishery and the in-river gillnet fishery only.
[2]Since 1988 data has been collected by Cowichan Indian Band River Management. Prior to 1988 data was collected by the local Fishery Officers.

Table 7. Broodstock collection[1] from the Cowichan R., 1990

Date	Males	Jacks	Females
Oct. 4	56	-	70
Oct. 5	19	-	68
Oct. 6	17	-	45
Oct. 9	8	-	20
Oct. 10	4	-	13
Oct. 23	5	1	1
Total:	109	1	217

[1]All fish were collected at the enumeration fence.

Table 8. Broodstock collection[1] for the Cowichan hatchery, 1991

	Below fence			At fence			Above fence		
Date	M	J	F	M	J	F	M	J	F
Sept.30				10	5	5			
Oct. 1				9	5	8			
2				17	8	23			
3				17	9	20			
4				9	5	15			
5				36	18	44			
6				9	4	9			
7				12	6	19			
8	2		3	28	14	39			
9	2	2	3	28	15	37			
10	0	0	0	22	12	23			
11	0	0	0	26	14	72			
12	28	15	31	16	8	13			
13	32	3	13	16	8	29	8	4	17
14	1	0	2	9	4	9	5	3	8
15	18	9	25	5	3	9	5	3	0
16	9	41	9	22	12	38	35	18	25
17	0	0	0	14	8	19	10	4	7
18	6	0	0	8	3	7	0	0	0
19	0	0	0	19	9	22	0	0	0
20	0	0	0	6	3	13	0	0	0
21	0	0	0	5	2	17	0	0	0
22	0	0	0	0	0	0	20	10	30
23	2	0	7	27	13	15	0	0	0
24	0	0	25			11	0	0	0
25	13	6	2				0	0	0
27	0	0	0				44	22	0
28	26	13	0				22	10	0
30	36	18	20				19	9	2
31	36	18					20	9	
Nov. 4	53	26					12	5	
6	16	8							
Totals:	280	159	140	370	188	516	200	97	89

[1]Based on hatchery records

Table 9. Summary of chinook broodstock collected at the enumeration fence, 1991

Date (ddmm)	Adults		Jacks		Adults		Jacks	
	Tagged[1]	Untagged	Tagged	Untagged	Clip[2]	Noclip	Clip	Noclip
3009	0	36	0	0	2	34	0	0
0110	0	32	0	0	1	31	0	0
0210	0	19	1	1	2	17	1	1
0310	0	57	0	2	3	54	2	0
0510	0	73	2	7	2	71	8	1
0610	0	58	0	9	2	56	9	0
0710	1	16	0	3	2	15	3	0
0810	0	68	0	8	5	63	8	0
0910	0	71	0	11	6	65	4	7
1010	0	24	1	2	0	24	2	1
1210	0	30	0	5	6	24	1	4
1310	0	40	0	9	2	38	2	7
1510	0	33	0	9	4	29	3	6
1610	0	98	0	18	3	95	4	14
1810	1	39	0	6	3	37	1	5
2010	0	16	0	4	4	12	4	0
2110	0	23	0	6	4	19	3	3
2310	0	2	0	0	0	2	0	0
Total:	2	735	4	100	51	686	55	49

[1]chinook tagged with Ketchum aluminum sheep ear tag
[2]adipose fin clipped chinook

Table 10. Adult chinook escapement used for hatchery broodstock, Cowichan River[a].

Year	No. of fish collected
1981	282
1982	534
1983	242
1984	278
1985	175
1986	315
1987	582
1988	678
1989	535
1990	327
1991[b]	2039

[a]Barry Cordecedo (Salmon Enhancement Program) provided numbers on broodstock collection from 1981-1987. The brood stock numbers provided included jacks, but no reliable records were kept. It was estimated that about 10-15 jacks were collected per year, except in the first few years in the Cowichan River. These estimates were subtracted from the broodstock numbers provided to give an estimate of the number of adult chinook removed from the system.

[b]In addition, 284 males were removed for broodstock but later returned to the river.

Table 11. Age composition of chinook broodstock collected by Cowichan hatchery.

1990

Age	Males	Females	Percent
2	6	0	2%
3	60	21	31%
4	24	147	65%
5	0	3	1%
UNK[1]	65		
Total	90	171	

1991

Age	Males	Females	Percent
2	252	1	22%
3	239	275	46%
4	94	245	30%
5	4	14	2%
UNK_1	250		
Total	591	535	

[1] Unreadable scale (due to resorption, regeneration, etc.)

Table 12. Summary of chinook sampled at the enumeration fence, 1990 and 1991.

1990

	Males	Jacks	Females
Sampled:	315	1346	400
Adipose clips:	16	31	9
Mark rate (%):	5.1	2.3	2.3

1991

	Males	Jacks	Females
Sampled:	435	112	511
Adipose clips:	24	6	39
Mark rate (%):	5.5	5.3	7.6

Table 13. Length-frequency of chinook and coho sampled from the Indian food fishery, 1990

Length[1] (cm)	CHINOOK M	CHINOOK F	CHINOOK T	COHO M	COHO F	COHO T
31	2	0	2	2	0	2
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	2	0	2	0	0	0
36	0	1	1	0	0	0
37	0	1	1	0	1	1
38	0	0	0	0	0	0
39	3	2	5	0	0	0
40	0	1	1	1	0	1
41	0	0	0	1	0	1
42	3	1	4	0	1	1
43	2	1	3	6	1	7
44	0	0	0	2	1	3
45	1	1	2	2	3	5
46	0	1	1	5	0	5
47	0	0	0	2	3	5
48	1	1	2	9	3	12
49	0	1	1	2	2	4
50	0	0	0	5	7	12
51	0	2	2	6	5	11
52	1	1	2	14	4	18
53	0	1	1	10	3	13
54	0	0	0	5	4	9
55	0	0	0	9	5	14
56	0	2	2	8	4	12
57	0	0	0	7	2	9
58	0	1	1	4	2	6
59	0	2	2	3	2	5
60	1	2	3	5	0	5
61	1	0	1	2	1	3
62	0	3	3	3	0	3
63	0	5	5	0	0	0
64	2	1	3	0	0	0
65	1	3	4	0	0	0
66	1	2	3	0	0	0
67	1	6	7	0	0	0
68	0	6	6	0	0	0
69	3	2	5	0	0	0
70	1	2	3	0	0	0
71	0	2	2	0	0	0
72	1	2	3	0	0	0
73	1	1	2	0	0	0
74	1	5	6	0	0	0
75	2	4	6	0	0	0
76	0	2	2	0	0	0
77	0	2	2	0	0	0
78	0	3	3	0	0	0
79	0	1	1	0	0	0
80	1	1	2	0	0	0
81	0	0	0	0	0	0
82	0	1	1	0	0	0
83	0	0	0	0	0	0
84	0	0	0	0	0	0
85	0	0	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	1	1	0	0	0
Total:	32	77	109	113	54	167
Adipose clip:	1	0		1	0	
Mark rate (%):	3.1			1.3		

[1]Hypural length

Table 14. Length-frequency of chinook and coho sampled from the Indian food fishery, 1991.

	CHINOOK			COHO		
Length[1] (cm)	M	F	T	M	F	T
33	0	0	0	1	0	1
34	0	0	0	0	0	0
35	0	0	0	0	0	0
36	0	0	0	0	0	0
37	1	0	1	0	0	0
38	0	1	1	0	0	0
39	0	0	0	0	1	1
40	2	0	2	0	0	0
41	0	0	0	1	0	1
42	1	1	2	0	0	0
43	2	1	3	0	0	0
44	2	0	2	0	0	0
45	3	1	4	0	0	0
46	5	2	7	1	0	1
47	1	0	1	0	1	1
48	6	0	6	0	0	0
49	2	2	4	1	0	1
50	3	1	4	0	0	0
51	0	1	1	2	0	2
52	4	1	5	2	0	2
53	3	0	3	1	0	1
54	4	0	4	2	0	2
55	7	1	8	1	0	1
56	1	2	3	2	0	2
57	0	0	0	0	1	1
58	0	1	1	0	1	1
59	0	3	3	0	0	0
60	2	1	3	1	0	1
61	0	2	2	0	0	0
62	2	4	6	3	0	3
63	1	1	2	0	0	0
64	1	3	4	0	0	0
65	6	1	7	0	0	0
66	3	1	4	0	0	0
67	3	0	3	1	0	1
68	2	0	2	0	0	0
69	1	1	2	0	0	0
70	0	1	1	0	0	0
71	0	2	2	0	0	0
72	0	0	0	0	0	0
73	0	2	2	0	0	0
74	1	1	2	0	0	0
75	0	0	0	0	0	0
76	0	1	1	0	0	0
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	0	0	0	0	0
80	0	0	0	0	0	0
81	0	0	0	0	0	0
82	0	0	0	0	0	0
83	0	0	0	0	0	0
84	0	1	1	0	0	0
Total:	69	40	109	19	4	23
Adipose clip:	5	0		2	0	
Mark rate (%):	7.2	0.0		5.0	0.0	

[1]Hypural length

Table 15. Summary of chinook age data from the Indian food fishery, 1990 and 1991.

1990

Age	Number	Percent
2	23	18%
3	17	13%
4	46	35%
5	6	4%
UNK[1]	40	
Total:	132	

1991

Age	Number	Percent
2	30	26%
3	40	35%
4	11	10%
5	1	1%
UNK[1]	32	
Total:	114	

[1]Scales were unreadable due to resorption

Table 16. Length-frequency of chinook broodstock collected by the Cowichan River hatchery, 1990

Length[1] (cm)	Males	Jacks	Females
41	3	0	0
42	1	1	0
43	0	0	0
44	0	0	0
45	0	0	0
46	0	0	0
47	0	0	0
48	2	0	0
49	1	0	0
50	0	0	0
51	3	0	0
52	2	0	0
53	5	0	0
54	1	0	0
55	3	0	0
56	3	0	0
57	6	0	3
58	4	0	0
59	3	0	2
60	11	0	5
61	8	0	7
62	5	0	3
63	2	0	6
64	5	0	7
65	4	0	9
66	6	0	8
67	3	0	5
68	3	0	18
69	4	0	18
70	2	0	16
71	3	0	17
72	5	0	11
73	1	0	12
74	2	0	13
75	1	0	17
76	0	0	7
77	3	0	9
78	1	0	2
79	0	0	8
80	0	0	6
81	0	0	2
82	1	0	2
83	0	0	1
84	0	0	0
85	0	0	1
86	0	0	0
87	0	0	2
88	0	0	0
89	0	0	1
90	0	0	1
Total:	107	1	219
Adipose clips:	11	1	1
Mark rate (%):	10.3		0.4

[1]Hypural length

Table 17. Length-frequency of chinook broodstock collected by the Cowichan River hatchery, 1991.

Length[1] (cm)	Males	Jacks	Females
30	0	1	0
31	0	0	0
32	0	2	0
33	0	2	0
34	1	5	0
35	0	4	0
36	0	7	0
37	0	16	0
38	0	24	0
39	0	23	0
40	1	30	0
41	0	28	0
42	2	40	0
43	0	29	1
44	2	20	0
45	3	12	0
46	4	6	0
47	3	7	0
48	3	5	0
49	2	3	0
50	4	2	0
51	5	1	0
52	6	0	1
53	7	1	0
54	11	1	4
55	11	1	6
56	14	1	7
57	11	0	7
58	17	0	21
59	16	0	16
60	26	0	30
61	27	0	32
62	21	0	39
63	20	0	47
64	19	0	39
65	34	0	39
66	26	0	53
67	22	1	39
68	22	0	42
69	13	0	37
70	15	0	38
71	12	0	30
72	17	0	29
73	11	0	26
74	7	0	19
75	4	0	17
76	5	0	5
77	11	0	6
78	6	0	6
79	4	0	9
80	1	0	5
81	1	0	3
82	0	0	0
83	0	0	0
84	1	0	1
85	0	0	1
86	0	0	0
87	0	0	0
88	0	0	0
89	0	0	0
90	0	0	0
91	1	0	0
Total:	449	272	655
Adipose clips:	84	246	136
Mark rate (%):	18.7	90.4	20.8

[1]Hypural length

Table 18. Length-frequency of chinook tagged at the enumeration fence, 1991

Length[1] (cm)	Adults	Jacks	Length (cm)	Adults	Jacks
30	1	4	67	23	0
31	0	6	68	33	2
32	0	6	69	26	0
33	0	16	70	32	0
34	0	16	71	22	0
35	0	14	72	38	0
36	0	35	73	13	0
37	1	33	74	15	0
38	0	33	75	14	0
39	0	45	76	26	0
40	0	55	77	4	0
41	0	41	78	20	0
42	1	66	79	10	0
43	1	54	80	15	0
44	1	34	81	5	0
45	1	31	82	8	1
46	3	33	83	4	0
47	0	23	84	7	0
48	0	13	85	4	0
49	2	27	86	2	0
50	5	5	87	2	0
51	1	5	88	0	0
52	7	6	89	1	0
53	3	4	90	1	0
54	16	2	91	0	0
55	8	1	92	0	0
56	15	1	93	1	0
57	12	1	94	1	0
58	19	0	95	1	0
59	21	2			
60	24	1			
61	27	0	Total:	616	650
62	34	0			
63	25	0			
64	32	0	Adipose clips:	42	46
			Mark rate (%):	6.5	7.5

[1] Hypural length

Table 19. Length-frequency of chinook sampled on the spawning grounds, 1991.

Length[1] (cm)	Males	Jacks	Females
28	0	1	0
29	0	1	0
30	0	1	0
31	0	3	0
32	0	5	0
33	0	10	0
34	0	9	0
35	0	8	0
36	0	13	0
37	0	9	0
38	0	17	0
39	0	14	0
40	0	11	0
41	0	10	0
42	11	0	0
43	8	0	0
44	15	0	0
45	3	0	0
46	8	0	0
47	3	0	0
48	2	0	0
49	4	0	1
50	5	0	0
51	6	0	1
52	6	0	4
53	5	0	5
54	7	0	3
55	13	0	4
56	13	0	5
57	18	0	7
58	26	0	12
59	17	0	12
60	22	0	13
61	26	0	21
62	9	0	17
63	15	0	17
64	19	0	23
65	15	0	33
66	18	0	37
67	16	0	39
68	15	0	25
69	20	0	47
70	15	0	41
71	18	0	27
72	12	0	27
73	10	0	27
74	13	0	18
75	5	0	14
76	5	0	12
77	4	0	6
78	4	0	1
79	3	0	2
80	0	0	5
81	1	0	2
82	0	0	1
83	0	0	0
84	0	0	0
85	0	0	0
86	0	0	2
Total:	435	112	511
Adipose clips:	24	6	39
Mark rate (%):	5.5%	5.3%	7.6%

[1]Hypural length

Table 20. Summary of chinook age data for fish sampled on the spawning grounds, 1991.

Age	Males	Females	Percent
2	123	5	47%
3	198	116	36%
4	127	287	15%
5	6	11	2%
Total:	454	419	

Number of regenerate scales read: 185

Table 21. Water temperature and depth at the enumeration fence site, 1990

Date		Depth (cm)	Temp. (Deg.C)
Sept.	12	140	19
	13	135	18
	14	126	17
	15	128	17
	16	138	18
	17	133	18
	18	133	18
	19	127	17
	20	132	17
	21	130	16
	22	125	17
	23	309	18
	24	305	19
	25	296	19
	26	296	18
	27	254	18
	28	128	17
	29	120	17
	30	120	16
Oct.	01	120	17
	02	115	15
	03	175	15
	04	327	16
	05	386	15
	06	373	14
	07	367	14
	08	342	15
	09	322	15
	10	326	15
	11	320	14
	12	348	14
	13	342	14
	14	342	13
	15	358	13
	16	360	13
	17	343	13
	18	395	13
	19	423	13
	20	392	13
	21	426	13
	22	408	13
	23	400	11
	24	370	12
	25	420	13

Table 22. Water temperature and depth at the enumeration fence site, 1991.

Date		Depth (cm)	Temp. (Deg.C)
Aug.	19	365	23
	20	365	22
	21	365	22
	22	362	22
	24	370	22
	25	365	18
	26	365	18
	27	390	18
	28	392	17
	29	410	17
	30	550	17
Sept.	10	910	18
	12	750	18
	13	720	19
	14	738	17
	15	641	17
	16	530	17
	17	548	18
	18	556	17
	19	543	18
	20	537	18
	21	531	17
	22	529	17
	23	533	16
	24	533	16
	25	530	16
	26	543	17
	27	549	18
	28	536	18
	29	537	17
	30	533	17
Oct.	01	530	16
	02	520	16
	03	514	15
	04	515	15
Oct.	05	596	16
	06	591	15
	07	620	15
	08	628	16
	09	628	16
	10	604	15
	11	524	15
	12	520	16
	13	528	15
	14	522	15
	15	520	15
	16	530	15
	17	525	14
	18	545	13
	19	538	14
	20	530	14
	21	473	14
	22	530	14
	23	528	12
	24	576	12
	25	575	13
	26	563	11
	27	555	11
	28	460	10
	29	466	10
	30	453	10
	31	570	10
Nov.	01	560	11
	02	550	11
	03	550	11
	04	560	11
	05	391	11
	06	562	11
	07	459	11
	08	246	11
	09	562	11
	10	563	11
	11	570	11

Table 23. Daily discharge[1] in cu.m/sec for 1990.

Day	May	Jun	Jul	Aug	Sep	Oct	Nov
1	33.60	15.60	7.56	5.49	5.44	5.82	71.20
2	32.50	16.20	7.94	6.07	5.74	6.41	68.30
3	31.10	22.90	7.88	5.44	6.68	8.38	69.80
4	30.00	32.80	7.23	5.24	6.93	19.10	68.80
5	28.00	36.50	7.23	5.38	6.61	19.90	65.50
6	27.90	36.90	7.59	5.51	6.04	19.10	62.20
7	26.20	42.10	7.37	5.52	5.53	18.70	62.50
8	23.40	47.30	6.89	5.65	5.67	18.10	61.40
9	22.50	48.30	6.87	5.48	5.62	17.70	107.00
10	21.70	55.70	6.46	5.40	5.50	17.80	196.00
11	17.80	54.80	6.26	5.54	5.47	17.60	246.00
12	16.40	53.70	6.04	5.40	5.69	18.60	225.00
13	16.00	50.90	6.19	5.02	5.22	18.80	258.00
14	15.70	47.60	6.17	4.99	4.91	19.00	233.00
15	14.40	44.10	7.22	4.89	5.23	19.90	220.00
16	13.70	37.70	6.77	5.66	5.58	19.30	211.00
17	12.70	32.20	6.70	5.69	5.37	19.00	211.00
18	9.67	30.60	6.73	5.41	5.61	22.10	199.00
19	9.71	26.50	6.37	5.25	5.56	23.20	187.00
20	9.50	24.60	5.96	5.13	5.68	22.60	171.00
21	9.79	22.90	5.85	5.19	5.30	26.80	162.00
22	10.70	21.80	5.98	5.07	7.29	26.70	176.00
23	10.10	20.50	6.03	5.23	15.80	25.90	266.00
24	9.09	19.30	5.78	5.76	15.50	26.50	283.00
25	8.83	18.10	5.87	5.38	15.70	40.40	247.00
26	8.40	12.70	5.98	5.10	15.10	57.20	222.00
27	8.64	11.60	5.69	5.20	12.20	57.00	205.00
28	9.11	9.40	5.44	5.25	4.97	61.60	194.00
29	9.40	7.78	5.85	5.12	5.11	65.80	236.00
30	9.43	7.42	5.70	5.67	5.50	74.40	213.00
31	11.80		5.35	5.94		73.60	
Total:	517.77	508.40	200.75	167.07	216.55	887.01	5197.70
Mean:	16.70	30.30	6.48	5.39	7.22	28.60	173.00

[1]Water Survey Canada data collected at the Island Hwy Bridge

Table 24. Daily discharge[1] in cu.m/sec for 1991.

Day	May	Jun	Jul	Aug	Sep	Oct	Nov
1	18.80	7.94	5.67	4.22	83.70	9.87	12.80
2	18.90	7.68	6.34	4.25	80.90	9.68	12.10
3	18.70	7.46	5.61	4.22	76.00	9.43	11.60
4	18.30	6.96	4.55	4.50	71.40	10.70	12.50
5	18.40	6.78	4.49	4.67	65.50	18.00	13.80
6	18.90	6.74	4.49	4.66	61.20	17.50	13.20
7	19.20	6.54	4.72	4.69	55.80	17.30	13.50
8	20.10	6.61	4.61	4.89	52.20	17.90	14.30
9	20.80	6.43	4.63	5.53	39.50	17.80	14.20
10	20.90	6.39	4.57	4.42	34.50	16.00	14.70
11	20.90	6.46	4.73	4.44	25.10	10.10	21.70
12	21.00	6.31	4.91	4.33	22.30	9.45	32.20
13	19.60	6.28	4.77	4.31	21.80	10.30	39.70
14	17.40	6.20	4.76	4.22	21.70	10.40	37.70
15	16.60	6.09	4.93	4.10	15.10	9.96	35.40
16	15.80	6.30	4.56	4.26	10.30	10.90	40.04
17	15.00	6.15	4.69	4.12	11.50	10.80	70.50
18	14.70	5.78	4.48	4.00	11.30	11.70	67.60
19	14.30	5.70	4.41	4.12	10.90	11.30	132.00
20	14.30	5.86	4.45	4.24	10.50	10.60	147.00
21	13.50	6.13	4.47	4.03	10.50	10.30	125.00
22	13.10	6.13	4.38	4.31	10.40	10.40	113.00
23	12.80	5.95	4.37	4.38	10.60	10.30	107.00
24	12.50	5.63	4.46	4.40	10.60	13.80	107.00
25	10.80	5.64	4.43	4.40	10.20	13.40	112.00
26	9.39	5.12	4.32	4.28	11.70	12.90	108.00
27	9.10	5.15	4.17	4.74	11.90	11.90	102.00
28	8.93	5.20	4.04	4.76	11.00	11.80	97.40
29	8.90	5.25	4.14	6.37	10.10	13.40	89.50
30	8.89	5.25	4.17	61.80	9.82	13.80	81.40
31	8.49		4.19	87.20		13.10	
Total:	485.60	186.50	143.50	278.55	888.02	384.79	1799.30
Mean:	15.70	6.20	4.64	8.99	29.60	12.40	60.00

[1]Water Survey Canada data collected at Island Hwy bridge.

Table 25. Summary of chinook tagged at the enumeration fence, 1991

Date	Adults		Jacks		Adults		Jacks	
(ddmm)	Tagged[1]	Untagged	Tagged	Untagged	Clip[2]	Noclip	Clip	Noclip
1709	4	0	20	0	0	4	0	20
2009	14	0	6	0	2	12	1	5
2309	18	0	32	2	1	17	1	33
2609	29	0	43	2	3	26	2	43
2709	18	0	36	0	0	18	1	35
3009	39	0	26	3	2	37	6	23
0110	7	0	13	0	0	7	0	13
0210	18	0	13	0	1	17	0	13
0310	6	0	28	0	0	6	0	28
0510	5	0	57	0	0	5	0	57
0610	3	1	33	0	0	4	2	31
0710	13	1	19	0	0	14	0	19
0810	11	0	18	1	0	11	0	19
0910	13	0	11	0	1	12	1	10
1010	16	1	8	0	1	16	0	8
1210	9	0	8	0	0	9	0	8
1310	3	0	1	0	0	3	0	1
1510	8	0	3	0	0	8	1	2
1610	21	0	20	1	0	21	0	21
1810	49	0	10	0	5	44	0	10
2010	20	0	10	1	1	19	2	9
2110	14	8	1	0	2	20	0	1
2310	34	0	17	0	0	34	2	15
2410	29	0	12	0	0	29	0	12
2510	34	0	19	0	2	32	3	16
2710	25	0	9	0	2	23	3	6
3010	31	0	22	0	2	29	0	22
3110	34	0	18	0	4	30	0	18
0111	60	0	46	0	6	54	9	37
0211	59	0	45	0	8	51	10	35
0611	10	0	12	0	2	8	2	10
Total:	654	11	616	10	45	620	46	580

[1] chinook tagged with Ketchum aluminum sheep ear tag
[2] adipose fin clipped chinook

Table 26. Summary of chinook recovered on the spawning grounds, 1991

Date	Males		Females		Males		Females	
(ddmm)	Tagged[1]	Untagged	Tagged	Untagged	Clip[2]	Noclip	Clip	Noclip
2410	0	34	0	26	2	32	1	25
2510	0	33	0	17	2	31	1	16
2810	0	3	1	2	1	2	1	2
2910	0	5	1	2	2	3	0	3
3010	0	45	1	43	2	43	4	40
3110	1	45	0	44	2	44	1	43
0111	0	43	0	47	1	42	5	42
0411	1	12	1	8	1	12	0	9
0511	1	52	0	81	1	52	7	74
0611	0	99	1	122	6	93	7	116
0711	2	114	3	43	8	108	5	41
0811	2	35	0	38	1	36	3	35
1211	0	20	0	30	1	19	4	26
Total:	7	540	8	503	30	517	39	472

[1] chinook tagged with aluminum sheep ear tag
[2] adipose fin clipped chinook

Table 27. Cowichan River hatchery chinook fry release summary.

Tag Code	BY	Number Tagged	Number Released	CWT % Mark	Release Date ddmmmyy:ddmmmyy	Release group[a]
024334	87	14298	14334	99.7	:18Apr88	Early
024729	87	25360	25424	99.7	:18Apr88	Early
024730	87	25869	25934	99.7	:18Apr88	Early
024731	87	27428	27497	99.7	18Apr88:18May88	Lake pen
024732	87	27271	27339	99.8	:18May88	Lake pen
024733	87	26911	26978	99.8	:18May88	Lake pen
024734	87	23521	23580	99.7	:18May88	Lake pen
024735	87	26719	26786	99.7	18Apr88:18May88	Late
024945	87	26461	26594	99.5	:25May88	Late
024946	87	26658	26792	99.5	:25May88	Late
024947	87	26761	26895	99.5	:25May88	Late
025008	87	26817	26952	99.5	:25May88	Late
024860	88	25117	25243	99.5	:28Apr89	Early
025012	88	26595	54768	48.6	:21May89	Late
025013	88	25982	54154	48.0	:21May89	Late
025015	88	23058	24894	92.6	:28Apr89	Early
025016	88	26821	26821	100.0	:28Apr89	Early
025017	88	27611	28175	98.0	:28Apr89	Early
025523	88	27531	56123	49.1	:21May89	Late
025524	88	27205	55378	49.1	:21May89	Late
025749	88	26922	133331	20.2	:15May89	Lake pen
025750	88	27036	133446	20.3	:15May89	Lake pen
025751	88	23106	130107	17.8	:15May89	Lake pen
025752	88	26169	132842	19.7	:15May89	Lake pen
020352	89	28287	28573	99.0	12Apr90:12Apr90	Early
020522	89	27072	36800	73.6	22May90:23May90	Late
020622	89	27787	37242	74.6	22May90:23May90	Late
020623	89	28164	37619	74.9	22May90:23May90	Late
020624	89	28331	37786	75.0	22May90:23May90	Late
020938	89	28312	28312	100.0	12Apr90:12Apr90	Early
020939	89	26218	26218	100.0	12Apr90:12Apr90	Early
026103	89	27145	27145	100.0	12Apr90:12Apr90	Early
026255	89	26400	119674	22.1	:14May90	Lake pen
026256	89	25693	119497	21.5	:14May90	Lake pen
026257	89	25790	119325	21.6	:14May90	Lake pen
026258	89	25219	118748	21.2	:14May90	Lake pen
020333	90	25687	94172	27.3	15May91:15May91	Lake pen
020334	90	25898	94384	27.4	15May91:15May91	Lake pen
020335	90	25739	94224	27.3	15May91:15May91	Lake pen

Table 27. (cont.)

Tag Code	BY	Number Tagged	Number Released	CWT % Mark	Release Date ddmmmyy:ddmmmyy	Release group[a]
020336	90	27135	27135	100.0	17Apr91:17Apr91	Early
020337	90	26631	26631	100.0	17Apr91:17Apr91	Early
020338	90	27046	27046	100.0	17Apr91:17Apr91	Early
020339	90	26721	34318	77.9	21May91:22May91	Late
020340	90	26993	34592	78.0	21May91:22May91	Late
020341	90	26533	33995	78.0	21May91:22May91	Late

[a]Release strategy:
Early: this group has generally been released in the lower river
Late: this group has generally been released in the upper river above Skutz falls
Lake pen: this group has been released from the lake pen site above the weir.

Table 28. Coded wire tag code data from chinook sampled on the spawning grounds, 1991.

Rec.Date (ddmm)	Length[1] (cm)	Sex[2]	Tag Code[3]	Rec. Loc.[4]	Rel. Loc.[5]
2410	635	F	np	R pool	
2410	447	M	2-4-27	R pool	Chemainus
2410	370	M	2-62-56	R pool	Lake pen
3010	638	F	2-50-08	R pool	Late
3010	630	M	2-55-36	R pool	Chemainus
3010	612	F	2-57-51	R pool	Lake pen
3010	556	F	2-55-36	R pool	Chemainus
3010	664	F	np	R pool	
3010	739	M	2-53-30	R pool	Chemainus
0111	629	F	2-50-17	R pool	Early
0111	756	F	np	R pool	
0111	552	F	np	R pool	
0111	667	F	2-47-31	R pool	Lake pen
0111	739	F	2-47-31	R pool	Lake pen
0111	756	M	2-47-33	R pool	Lake pen
0511	704	F	2-47-31	R pool	Lake pen
0511	689	F	2-47-32	R pool	Lake pen
0511	600	F	2-49-46	R pool	Late
0511	734	F	2-47-32	R pool	Lake pen
0511	682	F	2-49-46	R pool	Late
0511	633	F	2-48-60	R pool	Early
0511	696	M	np	R pool	
0511	703	F	np	R pool	
0611	724	F	2-49-46	R pool	Late
0611	734	M	nd	R pool	
0611	766	F	nd	R pool	
0611	439	M	2-06-22	R pool	Late
0611	720	F	2-47-33	R pool	Lake pen
0611	648	F	nd	R pool	
0611	741	M	2-47-32	R pool	Lake pen
0611	607	M	2-57-52	R pool	Lake pen
0611	653	M	2-49-45	R pool	Late
0611	652	F	2-47-32	R pool	Lake pen
0611	543	F	nd	R pool	
0611	534	F	2-57-51	R pool	Lake pen
0611	683	M	2-47-34	R pool	Lake pen
1211	716	F	2-47-31	R pool	Lake pen
1211	658	M	np	R pool	
1211	661	F	nd	R pool	
1211	625	F	2-47-33	R pool	Lake pen
1211	660	F	2-47-34	R pool	Lake pen
2510	339	M	nd	BLK 51	
2510	498	M	nd	BLK 51	
2510	715	F	2-53-32	BLK 51	Chemainus
0411	711	M	2-49-46	BLK 51	Late
0711	572	F	np	BLK 51	
0711	704	F	np	BLK 51	

Table 28. (con't)

Rec.Date (ddmm)	Length[1] (cm)	Sex[2]	Tag Code[3]	Rec. Loc.[4]	Rel. Loc.[5]
0711	706	M	2-47-33	BLK 51	Lake pen
0711	611	M	2-50-17	BLK 51	Early
0711	402	M	2-06-23	BLK 51	Late
0711	713	F	2-47-34	BLK 51	Lake pen
0811	680	F	nd	Shoot	
3110	577	M	2-50-16	Trestle	Early
3110	667	F	2-47-32	Trestle	Lake pen
3110	528	M	np	Trestle	
2810	529	F	12-50-17	Vimy	Early
2810	656	M	2-50-15	Vimy	Early
2910	685	M	2-47-30	Vimy	Early
2910	436	M	2-09-39	Vimy	Early
0711	457	M	2-06-24	Vimy	Late
0711	574	M	2-50-16	Vimy	Early
0711	609	F	2-47-33	Vimy	Lake pen
0711	590	F	2-50-17	Vimy	Early
0711	403	M	2-03-52	Vimy	Early
0711	391	M	2-06-24	Vimy	Late
0711	417	M	2-06-22	Vimy	Late
0811	580	F	nd	Below F	
0811	738	F	2-55-23	Below F	Late
0811	388	M	2-06-22	Below F	Late

Unidentified tag codes[6]:

2-47-33	Lake pen
2-50-16	Early
2-47-32	Lake pen
2-57-52	Lake pen
	np
	np

[1]Hypural length [2]M:Males, F:Females
[3]np refers to no pin found; nd refers to head recovered with no associated recovery data
[4]Recovery locations (refer to Fig.1):
R pool; Road pool
BLK 51; Block 51
Below F; Below counting fence
Trestle; 70.2 mi. train trestle
[5]Release locations:
Early; Early hatchery release (during April)
Late; Late hatchery release (during May)
Lake pen; Hatchery fish released from pens in Lake Cowichan (during May)
[6]refers to head recovered with no associated recovery data

Table 29. Tag recovery rate by section of the Cowichan River, 1991

Section	Carcasses examined		Tagged carcasses recovered		Mark incidence (%)
	No.	%	No.	%	
Upper[1]	930	88	7	47	0.7
Lower	128	12	8	53	6.3
Total:	1058		15		1.4

[1]River was divided above and below the train trestle (Block 70.2)

Table 30. Incidence of tagged chinook recovered on the spawning grounds, by period, in the Cowichan R., 1991

Recovery Period	Recovered with tag		Total Recovery		Mark incidence
	No.	%	No.	%	%
Oct. 20-26	0	-	117	10	-
Oct.27-Nov.2	4	27	283	27	1.4
Nov. 3-9	11	73	615	58	1.8
Nov. 10-16	0	-	50	5	-
Total:	15	-	1058	-	1.4

Table 31. Total adult chinook returns[1] to the Cowichan River, 1975-1991.

Year[2]	Natural spawner	Brood stock	Native catch	Total return
1975	6500		900	7400
1976	3460		1000	4460
1977	4150		1000	5150
1978	4370		500	4870
1979	8750	195	500	9445
1980	5950	337	1500	7787
1981	6050	282	1500	7832
1982	5450	534	450	6434
1983	4550	242	250	5642
1984	5050	278	355	5683
1985	3550	175	468	4193
1986	1250	315	481	2046
1987	1200	582	455	2237
1988	4712	678	681	6071
1989	996	535	1055	2586
1990	3838	326	604	4768
1991	3200[3]	1595	270	5065[3]

[1]These are calculated minimum estimates.
Natural spawner refers to: the numbers of adults recorded at the fence minus the number of adults removed for broodstock above the fence.
Broodstock refers to: the number of adults removed from the river for broodstock.
Total return refers to: the sum of the fence count, the number of adults removed for broodstock below the fence, and the number of adult chinook taken in the native food fishery below the fence. (This does not include any estimate of the number of adults removed by seals in the estuary)

[2]Data from 1975-1987 compiled from Fishery officers records and information from the Cowichan hatchery. Data from 1988 to 1991 was compiled from this study.

[3]Includes 2000 adult chinook estimated to have passed by the fence during the period of high water

FIGURES

Fig. 1 Cowichan River Survey Areas:

Swim survey areas:

1-Bird House pool
2-Road pool
3-Train trestle (mile 70.2)
4-Old pick-up site
5-Maple tree
6-Three Firs pool
7-Skutz Falls
8-Marie Canyon
9-Bible Camp
10-Cowichan side channel
11-Sandy pool
12-Sewer
13-JC pool

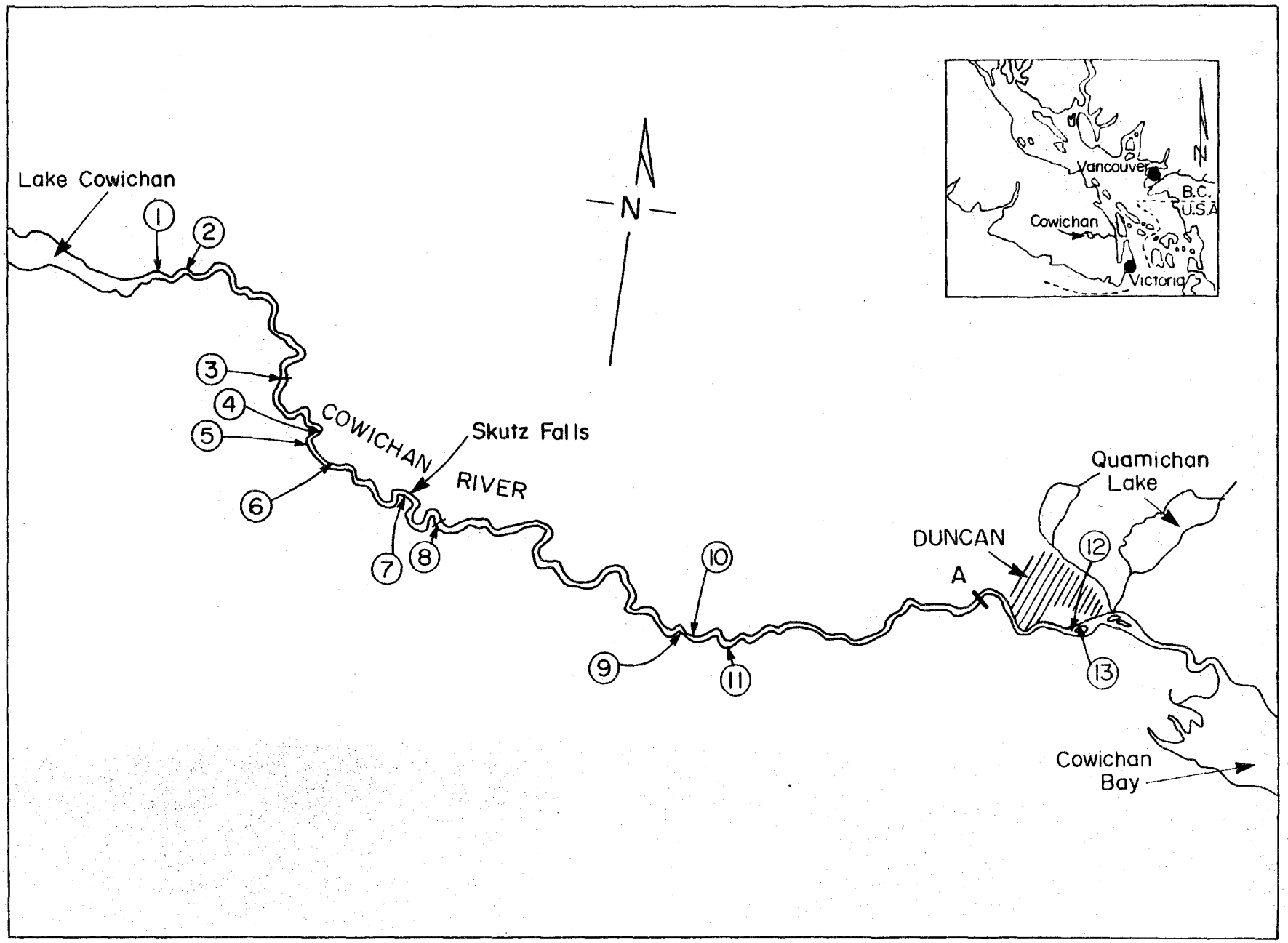
Carcass recovery survey areas:

Bird House (section 1) to Three Firs pool (section 6) represents the Upper survey section.

Marie Canyon (section 8) to enumeration fence (A) represents the Middle survey section.

Note: A-Adult enumeration fence

Note: Section of river that changed course in 1991 was between the Train Trestle (3) and the Old pickup site (4).


Lake Cowichan
1
2
3
4
5
6
7
8
9
10
11
12
13
COWICHAN
RIVER
Skutz Falls
DUNCAN
Quamichan
Lake
Cowichan
Bay
N
N
Vancouver
B.C.
U.S.A.
Cowichan
Victoria

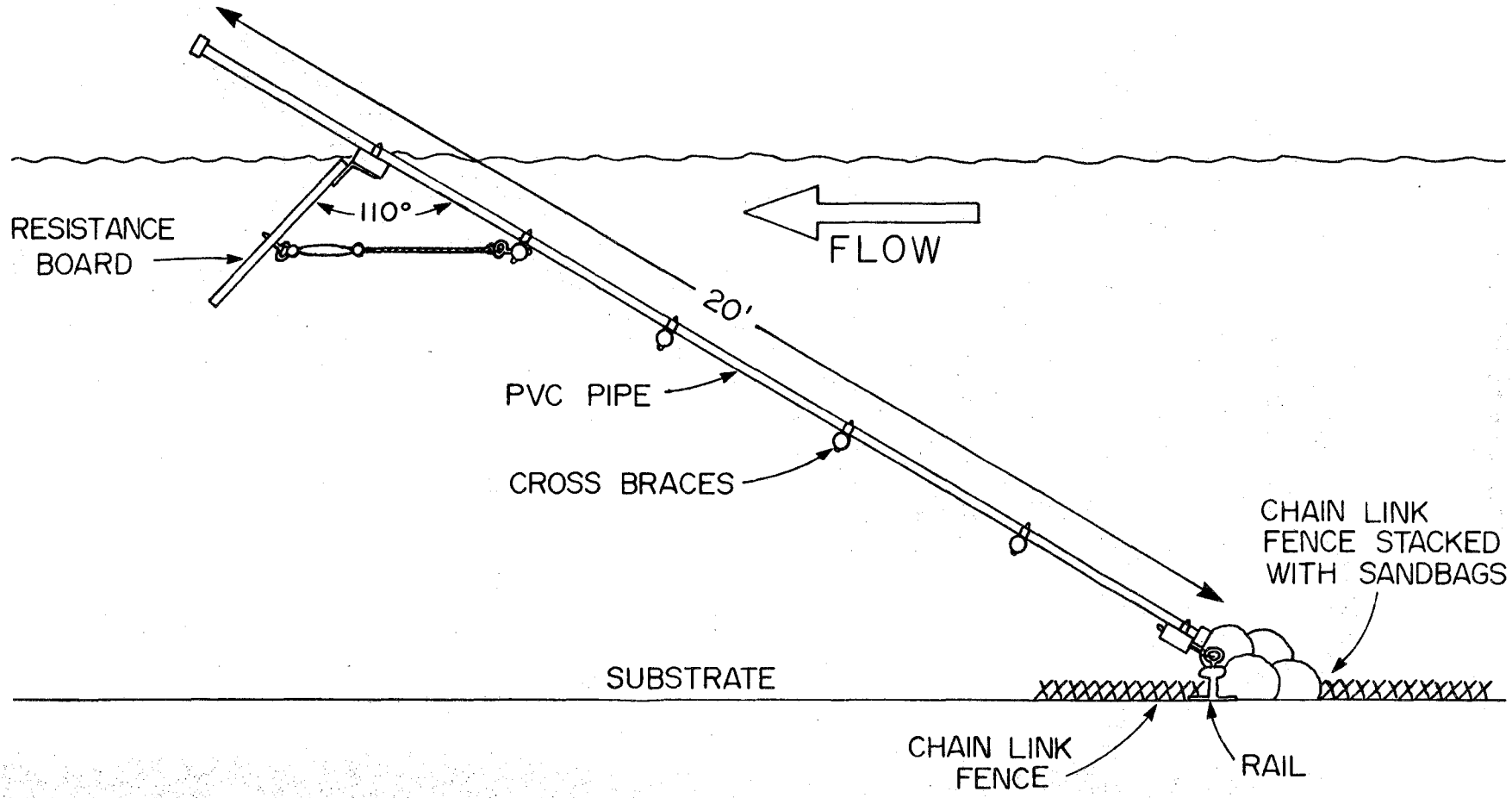


Fig. 2. Sideview of PVC fence structure.

Fig. 3 River Management Zones: (Native food fishery)

A-Cliffs to Silver bridge

B-Silver bridge to JC pool

C-Quamichan to Black creek

D-Powerline to Elliot's barn

E-Elliot's barn to Brian's pool

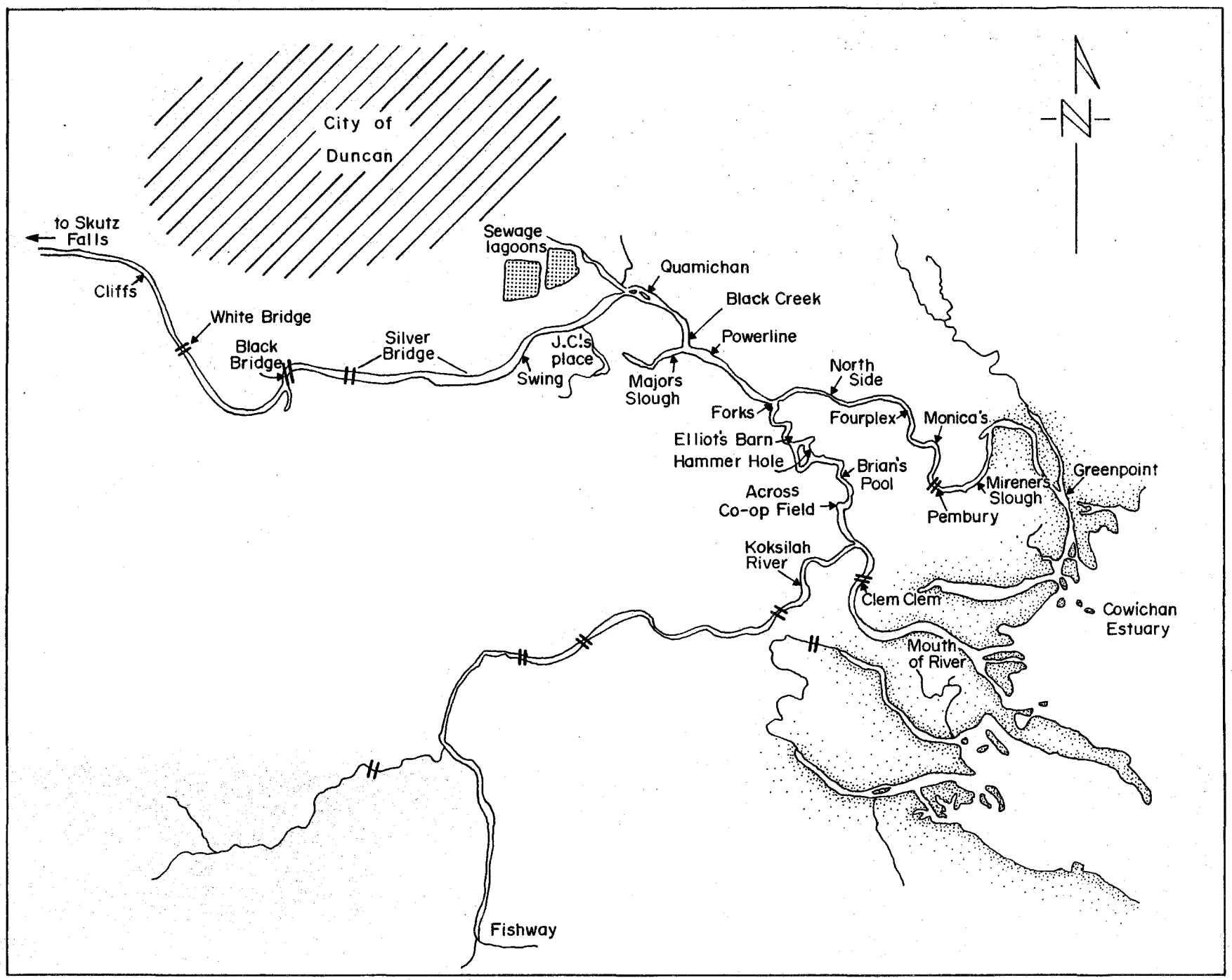
F-Brian's pool to Clem Clem and part of Koksilah

G-below Clem Clem to mouth

H-North fork to Fourplex Rd.

I-below Fourplex to Meriner's pool

J-Meriner's pool to mouth


City of
Duncan
to Skutz
Falls
Cliffs
White Bridge
Black
Bridge
Silver
Bridge
Sewage
lagoons
J.C.'s
place
Swing
Majors
Slough
Quamichan
Black Creek
Powerline
North
Side
Forks
Fourplex
Monica's
Elliot's Barn
Hammer Hole
Brian's
Pool
Across
Co-op Field
Koksilah
River
Pembury
Mireners
Slough
Greenpoint
Clem Clem
Cowichan
Estuary
Mouth
of River
Fishway

Cowichan R. 1990
Fence count vs Swim survey

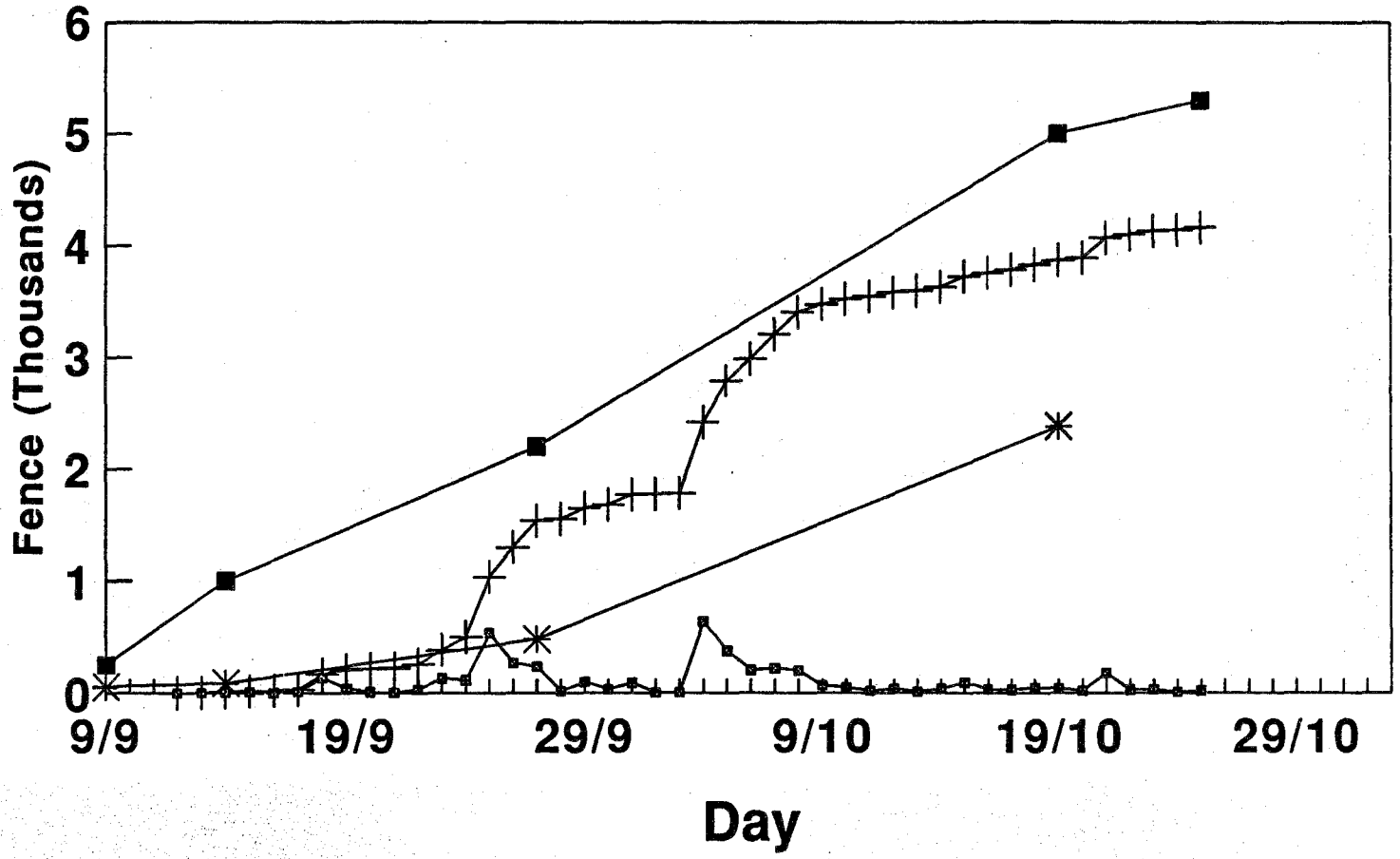


Fig. 4

Cowichan R. 1991
Fence Count vs Swim Survey

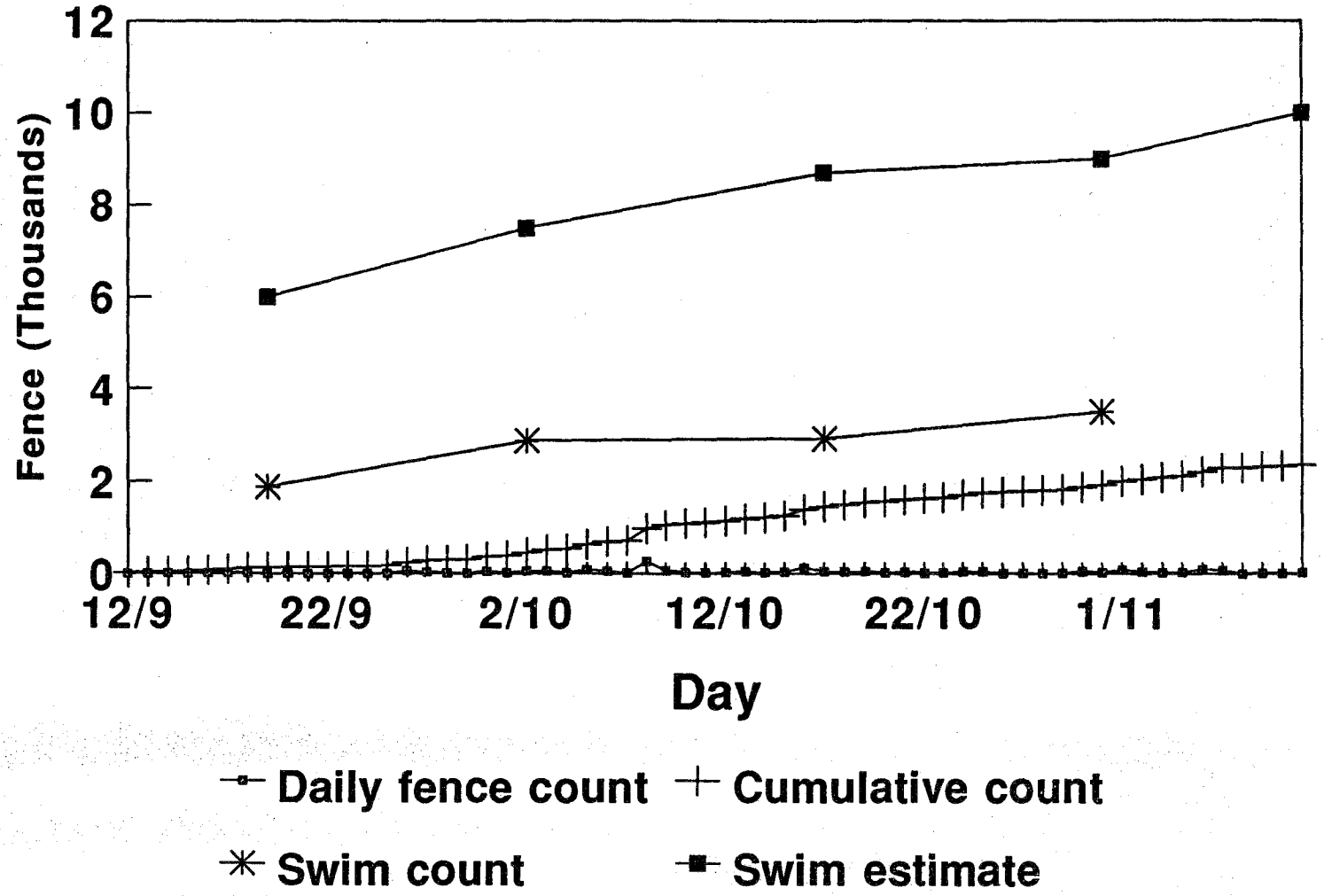


Fig. 5

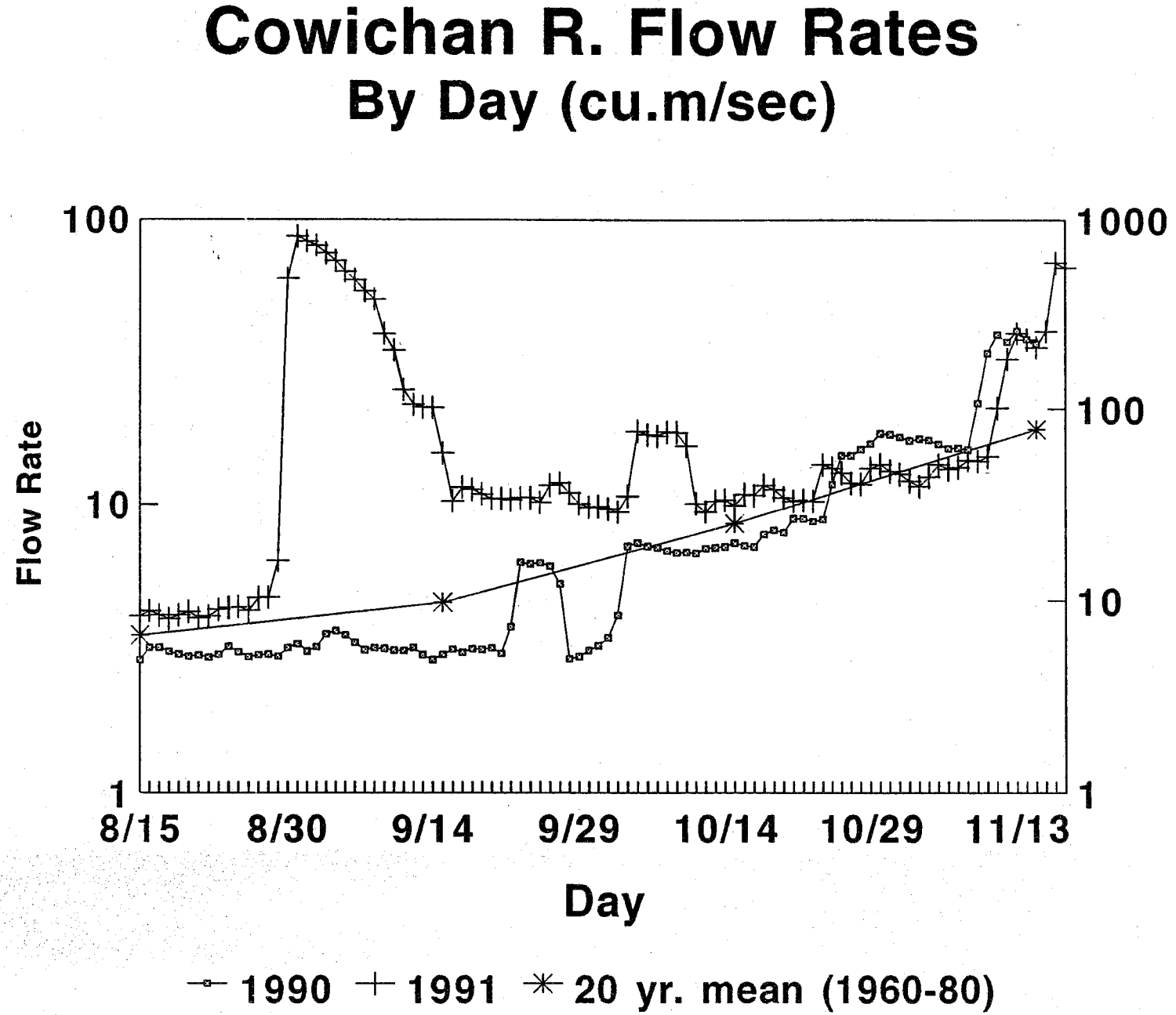


Fig. 6 Water Survey Canada data collected at Island Hwy bridge.

Cowichan R. 1990
Fence count vs Water Depth

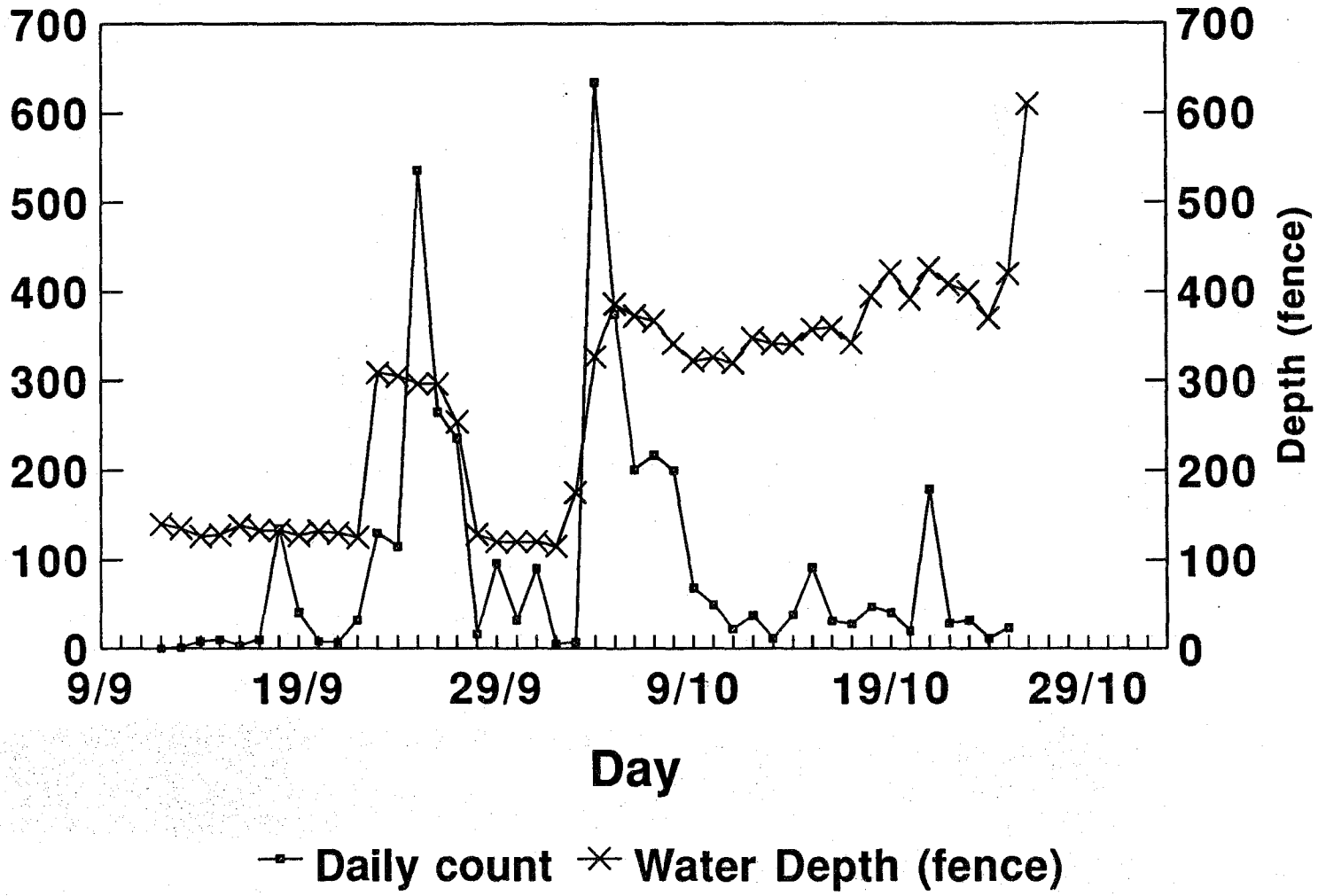


Fig. 7

Cowichan R. 1991
Fence Count vs Water Depth

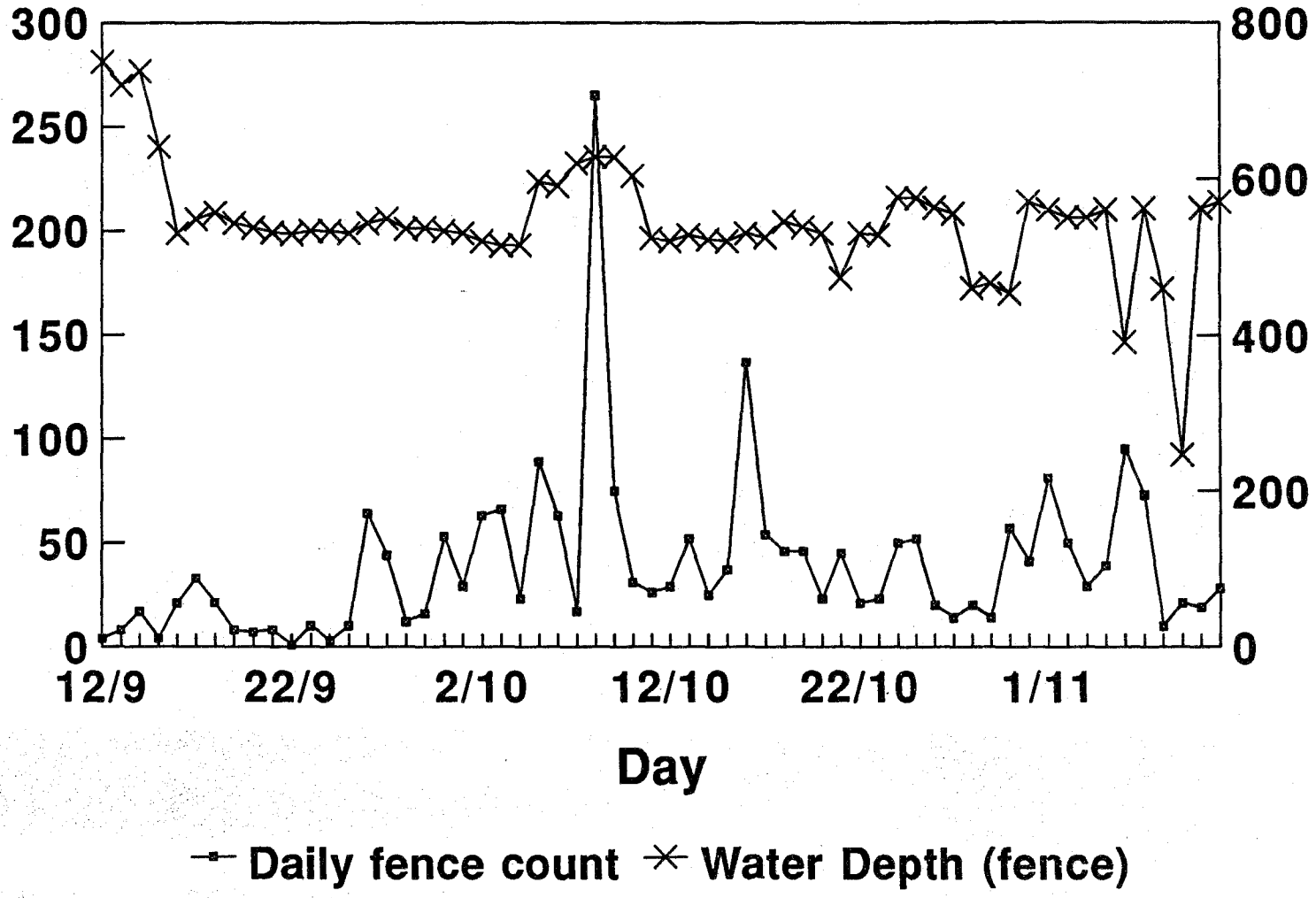


Fig. 8

Comparison of F/O visual and escapement estimates

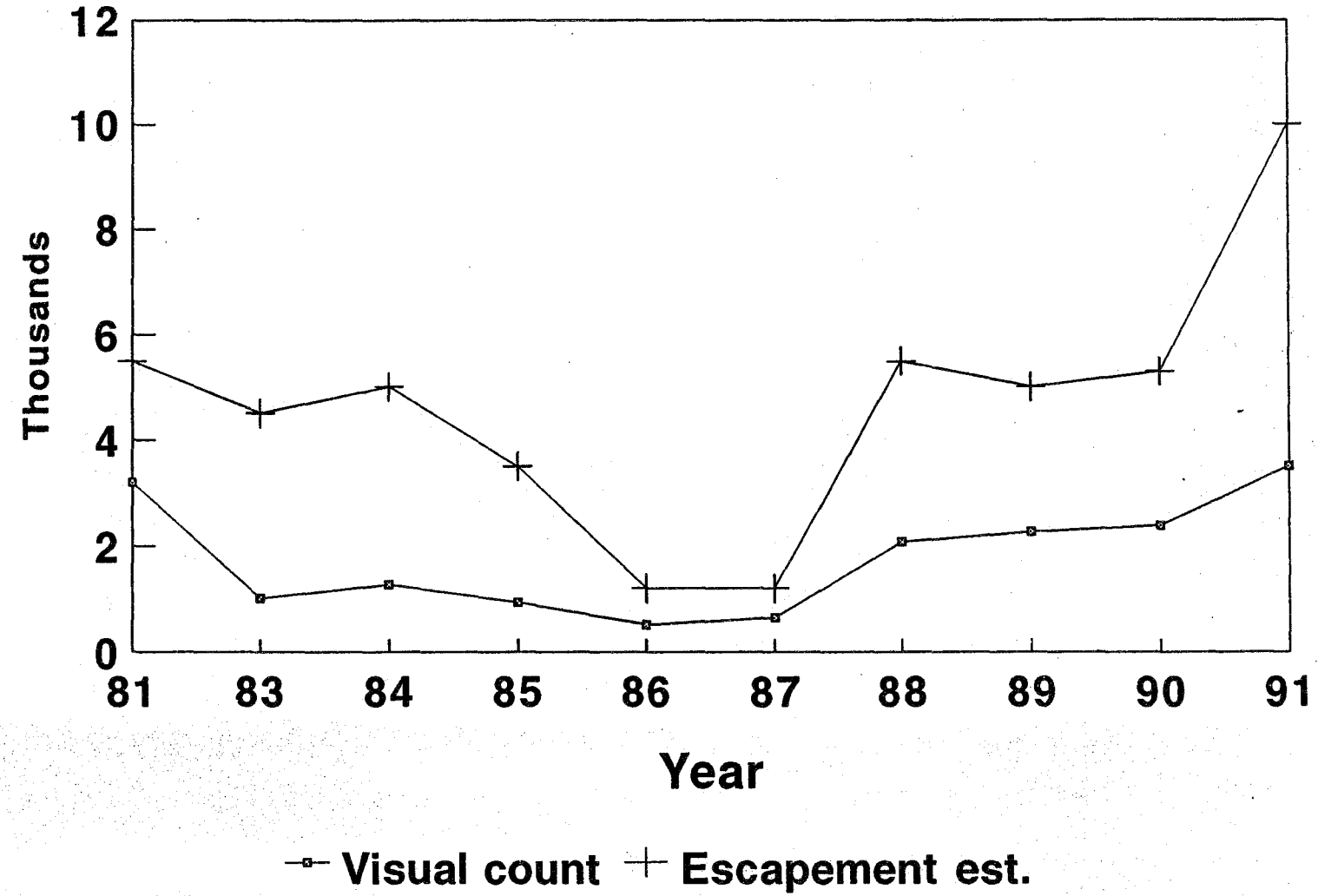


Fig. 9 Cowichan R. 1981-91