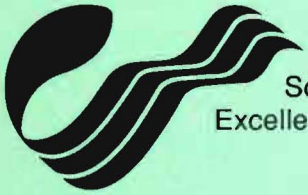

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A Coded Wire Tag Assessment of Salmon River (Langley) Coho Salmon: 1992 Tag Application and 1993-1994 Spawner Enumeration

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A CODED WIRE TAG ASSESSMENT OF SALMON RIVER (LANGLEY) COHO SALMON: 1992 TAG APPLICATION AND 1993-1994 SPAWNER ENUMERATION

by

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ABSTRACT

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

In 1986, the Department of Fisheries and Oceans implemented a plan to improve the assessment data for coho salmon (*Oncorhynchus kisutch*) through the long term evaluation of key stocks. The Salmon River (Langley) was selected for the evaluation, with known precision, of annual escapement, marine survival, harvest distribution and exploitation rate. In the spring of 1992, an estimated 28,141 (corrected for 8.8% long term tag loss) coho smolts were released with coded wire tags at an average size of 91.5 mm and 7.8 g. The adult escapement was estimated in fall and winter of 1993-1994 using the Petersen mark-recapture method. Escapement was estimated at 5,913 coho adults of which 1,079 had coded wire tags and 105 had lost the coded wire tag. Smolt to adult escapement survival averaged 3.8%.

Escapement progressively declined over the 1984-1989 brood years, from 11,947 in 1987 to 2,604 in 1992. In 1993, escapement increased to 5,913 but remained below the 1987-1992 average of 6,899.

Key Words: Coho salmon, Salmon River (Langley), key stream, coded wire tag, escapement, survival, exploitation rate.

RÉSUMÉ

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

En 1986, le ministère des Pêches et Océans a entrepris une évaluation à long terme des stocks clés pour améliorer la base de données sur le saumon coho (*Oncorhynchus kisutch*). Il a choisi de faire cette évaluation dans la rivière Salmon (Langley) et d'établir des données précises sur l'échappée annuelle, la survie, la répartition des captures et le taux d'exploitation. Au printemps de 1992, environ 28 141 (chiffre ajusté pour tenir compte des pertes à long terme de micromarques magnétisées codées, 8,8%) jeunes saumons mesurant en moyenne 91,5 mm, pesant en moyenne 7,8 g, et pourvus d'une micromarque magnétisée codée ont été relâchés. L'échappée des adultes a été estimée à l'automne et au hiver de 1993-1994 au moyen de la technique Petersen de marquage-recapture. L'échappée a été estimée à 5 913 poissons, dont 1 079 avaient encore leur micromarque et 105 l'avaient perdue. Le taux de survie des jeunes saumons atteignant l'échappée des adultes de 3,8%.

L'échappé a subit une baisse progressive de 1984 à 1989, de 11 947 poissons en 1987 à 2 604 poissons en 1992.

Mots clés: Saumon coho, rivière Salmon (Langley), cours d'eau important, micromarque magnétisée codée, échappée, survie, le taux d'exploitation.

INTRODUCTION

In 1986, the Department of Fisheries and Oceans implemented a plan to improve coho salmon (*Oncorhynchus kisutch*) assessment data through the long term evaluation of key stocks. The Salmon River was selected for the evaluation, with known precision, of annual escapement, marine survival, harvest distribution, and exploitation rate. This stock was selected for three reasons. First, because recent escapements comprised 4% of the Fraser River total (Farwell *et al.* 1987), the status of Salmon River coho was an important measure of the status of the Fraser River coho resource. Second, 1976-1978 brood year studies (Schubert 1982; Schubert and Fleming 1989) provided a time series of comparable escapement, survival and exploitation rate data. Third, manageable logistics limited project costs.

This report documents, for the 1990 brood, the 1992 smolt coded wire tag (CWT) application and the 1993-1994 adult escapement estimation studies. Previous reports documented the evaluation of the 1984-1989 brood years (Schubert and Kalnin 1990; Farwell *et al.* 1991, 1992a, 1992b; Kalnin and Schubert 1991; Schubert *et al.* 1994). This report describes the field methods, analytic techniques and study results, including smolt timing, age and size as well as adult age, length, sex, adipose fin clip (AFC) incidence, escapement estimates and long term CWT loss. The study did not estimate the escapement of precocious males (jacks). The report includes a discussion of data limitations and a synthesis of study results for the 1984-1990 brood years.

STUDY AREA

The Salmon River flows northwest for 33 km, entering the Fraser River west of Fort Langley, B.C. (Fig. 1). Coghlan Creek, the principal tributary, joins the mainstem 14 km upstream from the Fraser River. The system, with an average annual discharge of 1.41 $m^3 \cdot s^{-1}$ (Environment Canada 1980), drains 85 km^2 of agricultural and residential land. During the Fraser River spring freshet, the Salmon River flows through a pumphouse located at the river mouth. Because no provisions were made for fish passage, up to 31% of the coho smolts are killed as they pass through the pumps (Russell MS 1981). The study area was divided into ten reaches, five in the Salmon River and five in Coghlan Creek (Fig. 1). Reaches were established to accommodate statistical tests for bias rather than on the basis of homogeneity of physical characteristics. In most study reaches, the river flows across low gradient terrain in a shaded, meandering channel with a gravel substrate. The only exceptions are reaches C5 and S5 where the river is marshy and summer flows are low.

FIELD METHODS

SMOLT CAPTURE

Fence traps similar to those described by Schubert (1982) operated in the Salmon River (30 m above the Coghlan Creek confluence) and in Coghlan Creek (30 m above the Salmon River confluence) from April 16 to June 1, 1992. Captured fish were enumerated at least once daily. Coho smolts were transferred to holding boxes or to the tagging site for tagging and sampling. Coho fry were not enumerated because the 6 mm fence mesh did not fully restrict their passage. The remaining catch was identified to species and released below the fence. Steelhead (*O. mykiss*) and cutthroat (*O. clarki*) trout were recorded as smolt or presmolt. Trout smolts had a silver coloration and nose-fork (NF) length greater than 110 mm. Presmolts had distinct parr marks and a length of less than 110 mm.

CODED WIRE TAG APPLICATION

The CWT equipment and methods were described by Armstrong and Argue (1977). Coded wire tagging occurred from April 21 to June 1, 1992 at intervals of one to five days. On each day, smolts were sorted by size (NF length greater or less than 100 mm) and separate nose moulds and implant depths were used for each group. Implant depth was checked by bisecting the skull of a tagged smolt along the medial plane. If the CWT was not in the preferred position in the cartilaginous wedge of the skull, the implant depth was adjusted and the procedure repeated until CWT placement was correct. The nose mould was then marked to ensure correct placement following nose mould changes. The smolts were anaesthetized with Tricaine Methane Sulfonate (TMS), marked by adipose fin removal, coded wire tagged and passed through a quality control device to ensure the CWT was present. Any diseased, damaged or undersize (NF length less than 55 mm) smolts were released untag-

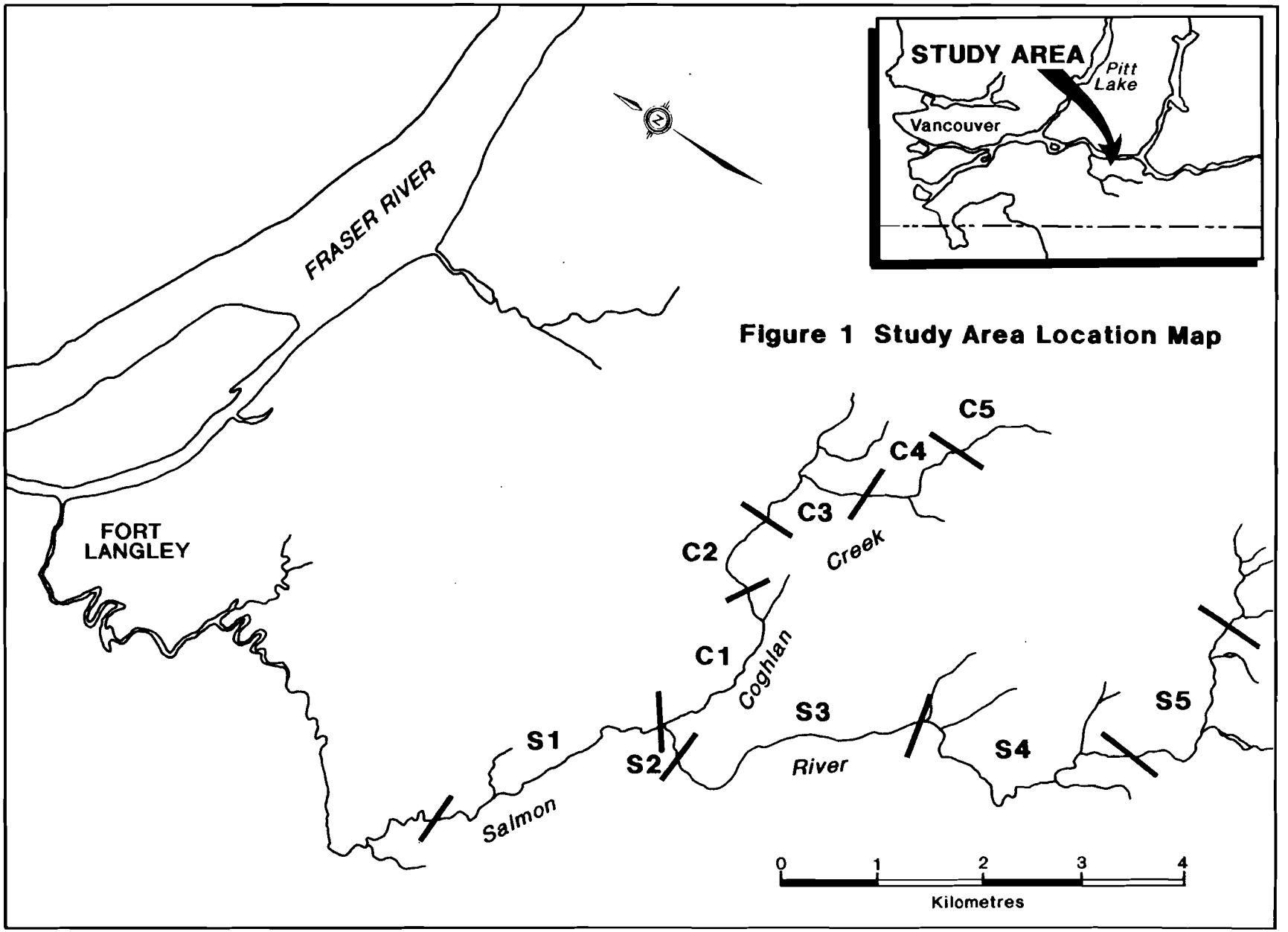

Figure 1 Study Area Location Map

ged. A sample of approximately 200 smolts was removed from the recovery bucket and retained for 24 hours to assess AFC quality, delayed mortality and CWT loss. Any smolt without a CWT or with a poor AFC was retagged or reclipped.

SMOLT TRANSPORT

To avoid pump mortality, the coho smolts were transported to and released at the river mouth, either immediately after tagging or in the morning when water temperatures were lower. The smolts were transported in a 180 litre plastic container supplied with air from a 12 volt air pump. Transport required less than 15 minutes.

SMOLT SAMPLING

Fifty coho smolts per site were sampled twice weekly for scales, length and weight. The smolts were anaesthetized with TMS, a scale smear was removed with a scalpel from each side of the fish, NF length was measured to the nearest millimetre, and mean wet weight (±0.1 g) was determined in aggregate using a triple beam balance.

ADULT CAPTURE

Coho adults were captured in reaches S1 to S5 and C1 to C5 (Fig. 1) from October 27 to December 20, 1993. Coho were attracted from log jams and cut banks with a Smith Root Model 12° 24-volt direct current electroshocker. Voltage, amperage, pulse width and frequency were adjusted daily to minimize visible damage (body bruising) while providing sufficient torpor to permit capture. Shocked coho adults (NF length greater than 30 cm) were captured in a dip net, permitted to recover in a 60 litre container of water, marked and released.

Coho adults were marked with Petersen disk tags in a wooden tray (10 cm x 10 cm x 100 cm) constructed with a flexible plastic bottom and a metre stick recessed in one side. The tags consisted of two 22 mm diameter laminated cellulose acetate disks and one 7 mm diameter transparent plastic buffer disk threaded through centrally punched holes onto a 77 mm long nickel pin. The pin was inserted with pliers through the musculature and pterygiophore bones approximately 12 mm below the anterior portion of the dorsal fin insertion. The disk tags, arranged with one on each side of the fish and with a buffer disk on the pin head side, were secured by twisting the pin into a double knot. One disk per pair was numbered with a unique code. Green tags were used to reduce colour contrast, thereby minimizing recovery and predation biases. Each tagged fish received a secondary mark, a 7 mm diameter hole punched through the right operculum using a single hole paper punch, to allow the estimation of tag loss. Males and females received one and two punches, respectively, to permit the estimation of sex identification error. Care was taken to avoid gill tissue damage. Date and location (reach) of capture, disk tag number, NF length (±0.5 cm), sex and adipose fin status were recorded for each fish released with a disk tag. Activity at release was recorded as 1 (swam away vigorously), 2 (swam away sluggishly) or 3 (required ventilation). Electroshocker bruising to the body was recorded as 0 (none), 1 (faint bruise), 2 (bruise up to 25 mm in diameter), 3 (bruise over 25 mm in diameter). Recovered disk tagged carcasses were enumerated and sampled (described below) to assess handling mortality.

SPAWNING GROUND SURVEYS

The spawning grounds were surveyed weekly from November 10, 1993 to January 21, 1994. Complete surveys, conducted by a two to four person crew walking upstream, required up to two days. Live adults were counted and carcasses were recorded by date, reach, sex (confirmed by abdominal incision) and mark type (disk tag, secondary mark or AFC). Each marked carcass and every tenth unmarked carcass was sampled. All carcasses were then cut in two with a machete and returned to the river. Sample data, recorded by date and reach, included post-orbital-hypural plate (POH) length (to the nearest 0.1 cm), sex, female spawning success (0%, 50% or 100% spawned), adipose fin and carcass condition, and scale samples. For AFC coho, the head was removed posterior to the eye orbit for later CWT identification. Adipose fin condition was recorded as unclipped, complete (flush with dorsal surface), partial (nub present) or questionable (appeared clipped but fungus or decomposition obscured the area). The condition of AFC carcasses was recorded as fresh (gills red or mottled), moderately fresh (gills white, body firm), moderately rotten (body intact, flesh soft) or rotten (skin and bones), and the absence of one or both eyes was noted.

ANALYTIC PROCEDURES

TESTS FOR SAMPLING SELECTIVITY

Period

Temporal bias was assessed using a chi-square test (Sokal and Rohlf 1981). Application bias was examined by comparing between periods the mark incidence in the recovery sample, where mark incidence was the proportion of the coho adults marked with either a disk tag or a secondary mark. Recovery bias was examined by stratifying the application sample by period and comparing proportions recovered.

Location

Spatial bias was similarly assessed in the application sample by comparing between sections the mark incidence in the recovery sample. Recovery bias was examined by stratifying the application sample by section and comparing the proportions recovered.

Fish Size

Size related bias was assessed using the Kolmogorov-Smirnov two-sample test (Sokal and Rohlf 1981). Application bias was examined by comparing the POH length-frequency distributions of marked and unmarked spawning ground recoveries. Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing the NF length-frequency distributions of each.

Fish Sex

Sex related bias was assessed using chi-square tests. Application bias was examined by comparing the sex ratio of the marked and unmarked spawning ground recoveries. Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing the sex composition in each.

Other Tests

Bias resulting from tagging stress was also assessed using chi-square tests as above. The application sample was partitioned into those fish which required ventilation at release and those which did not, and those with electroshocker bruising at release and those with none. Recovery rates were compared in each group. As well, spawning success was compared in marked and unmarked spawning ground recoveries.

ESTIMATION OF SPAWNER POPULATION

Total Escapement

The 1993-1994 escapement of Salmon River coho adults was calculated from the mark-recapture data using the Petersen formula (Chapman modification) (Ricker 1975). Total escapement was the sum of escapement by sex:

1) Estimated Salmon River system coho escapement (N_t):

$$N_t = N_m + N_f$$

where:

N_m = estimated escapement of adult males;

$$= \frac{(M_m + 1)(C_m + 1)}{(R_m + 1)}$$

N_f = estimated escapement of females, analogous to above.

2) Ninety-five percent confidence limits of N_t:

$$N_t \pm 1.96 \sqrt{V_t}$$

where:

N_t = total escapement estimate;

V_t = variance of the escapement estimate;

$= V_m + V_f$

V_m = variance of the adult male escapement estimate;

$$= \frac{(N_m^2)(C_m - R_m)}{(C_m + 1)(R_m + 2)}$$

N_m = adult male escapement estimate;

C_m = number of adult male carcasses examined for disk tags;

R_m = number of disk tagged or secondary marked males recovered;

V_f = variance of female escapement estimate, analogous to above.

Sex Identification Correction

The tag application data were corrected for sex identification error. Error occurred because the development of sexually dimorphic traits was often not advanced and internal examinations could not be made. The correction of the recovery data was unnecessary because all carcasses were incised and examined internally. Sex identification error was corrected as described by Staley (1990):

3) Estimated true number of males released with disk tags and secondary marks (M_m):

$$M_m = \frac{M^*_m - (M_t R_{m,f})/R_f}{1 - (R_{m,f}/R_f) - (R_{f,m}/R_m)}$$

where:

M^*_m = field estimate of the number of males released with disk tags and secondary marks;
M_t = total number of coho adults released with disk tags and secondary marks;
$R_{m,f}$ = number of females recovered with disk tags which were released as males;
$R_{f,m}$ = number of males recovered with disk tags which were released as females;
R_f = number of females recovered with disk tags;
R_m = number of males recovered with disk tags.

4) Estimated true number of females released with disk tags and secondary marks (M_f):

$$M_f = M_t - M_m$$

Adipose Fin Clipped Escapement

We estimated the AFC escapement from the AFC incidence in the carcass recovery sample, the largest of the two available samples. The AFC incidences in the Salmon River and Coghlan Creek were first tested for significant differences using a chi-square test. If no difference was noted, the AFC escapement was the product of the pooled AFC incidence and the mark-recapture escapement estimate. Ninety-five percent confidence limits were calculated from the respective upper and lower confidence limits of the AFC incidence and the escapement estimate. For example, the upper 95% confidence limit of the AFC escapement estimate was the product of the upper limit of the AFC incidence and the upper limit of the total mark-recapture estimate. The mathematical relationships are reported below (Cochran 1977):

5) Estimated AFC escapement (N_a):

$$N_a = p\,(N_t)$$

6) Ninety-five percent confidence limits for p:

$$p \pm 1.96\,(se + fpc)$$

where:

p = sample proportion with an AFC;
se = standard error;
$= (1 - f)pq/(n - 1)$
fpc = finite population correction;
$= \frac{1}{2n}$
n = sample size;
$q = 1 - p$
$f = \frac{n}{N_t}$

If the Salmon River and Coghlan Creek AFC incidences differed, then the AFC escapement estimate was the product of the stream-specific total escapement, the stream-specific AFC incidence, and the pooled CWT retention level. Total escapement by stream was calculated by applying the ratio of the stream-specific Schaefer estimates to the Petersen estimate. Confidence limits, therefore could not be reported for the AFC escapement using this method.

Coded Wire Tagged Escapement

Escapement by CWT code and long term CWT loss were calculated by applying the CWT composition in the carcass recovery sample to the estimated escapement of AFC adults. Apparent CWT loss was adjusted for post-mortality loss resulting from carcass decomposition and predator activity, where appropriate.

HARVEST SAMPLING

This report provides estimates of total CWT harvest for the 1984-1989 brood years. The harvest data were obtained from the regional mark recovery program data base (Kuhn *et al.* 1988) and were treated for sampling problems as described by Schubert *et al.* (1994). Harvest estimates for the 1990 brood year are unavailable but will be provided in next year's report.

RESULTS

SMOLT CAPTURE

Catch of coho smolts totalled 34,707 in 1992, 17,396 in Salmon River and 17,311 in Coghlan Creek (Appendix 1). The 50% migration and the peak daily catch occurred on May 6 and April 27, respectively, in the Salmon River and on May 7 and May 6, respectively, in Coghlan Creek. High discharges rendered the traps inoperable for seven days (April 29 to May 5) in the Salmon River and seven days (April 18 and April 29 to May 4) in Coghlan Creek. The reported timing of the 1992 smolt migration, therefore, may be somewhat biased.

CODED WIRE TAG APPLICATION

AFC and CWT releases totalled 31,384 coho smolts in 1992 (Appendix 2). When adjusted for long term CWT loss (8.8%) (Appendix 9) and short term (24-hour) post tagging mortality (Appendix 2), the number released with CWTs and identifiable AFCs was 28,141. Short term CWT loss averaged 1.1% (range 0.0% to 6.2%) (Appendix 2). The incidence of disease, damage, or structural anomalies averaged 14.5% (Appendix 3). The most prevalent condition was 'fog eye' (14.1%), a reversible condition associated with capture stress. Seven naturally missing adipose fins (0.02%) were observed.

COHO SMOLT AGE AND SIZE

Of the smolts sampled emigrating from the Salmon River system, 0.7% were age 0+, 98.8% were age 1+ and 0.5% were age 2+. Smolt size averaged 90.0 mm and 7.5 g in the Salmon River and 93.0 mm and 8.1 g in Coghlan Creek (Appendix 4). Weighted mean smolt size was 91.5 mm and 7.8 g. Smolt size declined through the migration period.

DISK TAG APPLICATION

Disk tags and secondary marks were applied to 490 coho adults in the Salmon River system from October 27 to December 20, 1993 (Appendix 5); 78 (15.9%) had an AFC. Three hundred and forty-two tags (69.8%) were applied in the Salmon River and 148 (30.2%) in Coghlan Creek; most were released in reaches S1 (41%), C1 (21%) and S3 (16%).

Sixty fish (12.2%) required ventilation at release; however, the proportion of this group recovered (21.7%) was not significantly different ($p > 0.05$; chi-square) from the remaining fish (16.5%) (Table 2). Electrochocker bruising was noted in 270 fish (55.2%) (Table 2); however, the proportion of this group recovered (17.4%) was not significantly different ($p > 0.05$; chi-square) than the unbruised group (16.4%)(Table 2). Consequently, neither of these groups of fish were removed from the application sample.

An estimated 2.4% of the females and none of the males were misidentified at the time of tagging (Appendix 6). When adjusted for this error, an estimated 283 (57.8%) males and 207 (42.2%) females were released with disk tags and secondary marks (Table 1).

The mean NF length of females (54.0 cm) was significantly larger ($p < 0.05$; ANOVA) than males (51.8 cm) and, in both sexes, fish with AFCs (males 50.5 cm, females 52.5 cm) were smaller than unmarked fish (males 52.0 cm, females 54.3 cm). This difference was significant ($p < 0.05$), however, only in females.

In 1993-1994, 11 previously tagged fish were recaptured in later capture efforts. Recaptures were not recorded after November 15; therefore, this figure is not representative of vulnerability of marked fish to repeated capture.

SPAWNING GROUND RECOVERY

One thousand and forty-six adults and 1 jack were recovered on the spawning grounds from November 10, 1993 to January 21, 1994 (Table 1; Appendix 7). Of the adults identified to sex, 490 (47.0%) were male and 553 (53.0%) were female; 209 (20.0%) of the adults had an AFC, 81 (7.7%) had a disk tag and secondary mark, 3 (0.3%) had no secondary mark and none

Table 1. Disk tag application, carcass examination and mark recovery, by sex, of Salmon River system coho adults, 1993-1994.

Sex	Disk tags applied a	Carcasses examined	Marks recovered: Disk tag and secondary mark	Marks recovered: Secondary mark only	Marks recovered: Disk tag only	Marks recovered: Total	Percent recovered
Male	283	490	41	0	2	43	14.8%
Female	207	553	40	0	1	41	19.8%
Total	490	1,046 b	81	0	3	84	17.1%

a. Corrected for sex identification error.

b. Includes 3 chinook of unknown sex.

had lost a disk tag. The proportion of disk tagged fish which was recovered was significantly higher ($p > 0.05$; chi-square) in those with AFCs (29.5%) than in those without an AFC (14.8%).

The distribution of recoveries was 518 adults (49.4%) in the Salmon River and 528 (50.5%) in Coghlan Creek. Most were recovered in reaches C1 (21%), S4 (19%), S3 (13%) and C2 (12%).

Age, Length and Sex

The age and length of the 1993-1994 spawning ground recoveries are reported in Appendix 8. Age 3_2 fish comprised 98.9% of the adult males and 96.5% of the females. No difference in age composition was noted between streams or by AFC status ($p > 0.05$; chi-square). The mean POH length of females (43.9 cm) was significantly larger ($p < 0.05$; ANOVA) than that of males (41.4 cm). In both sexes, fish with AFCs (males 41.0 cm, females 43.3 cm) were smaller than unmarked fish (males 41.9 cm, females 44.8 cm); however, the difference was significant ($p < 0.05$; ANOVA) only in females.

Coded Wire Tag Recoveries

Eighty-eight adult males and 120 females were recovered with an AFC, an incidence of 18.0% and 21.7%, respectively. The AFC incidence was not significantly different ($p > 0.05$; chi-square) between streams or sexes (Appendix 9). CWTs were recovered from 71 adult males and 69 adult females; all were 1990 brood Salmon River system coho. There was a significant difference ($p < 0.05$; chi-square) in the spatial distribution of the CWT codes released at a single site. Recoveries in the Salmon River were largely (77.5%) of Salmon River origin, while those in Coghlan Creek were largely (91.7%) of Coghlan Creek origin (Appendix 9). There was no difference ($p > 0.05$; chi-square) in the temporal pattern of recoveries between CWT codes.

CWT loss was lower in carcasses with both eyes (18.0%) versus those missing one or both eyes (41.2%) ($p < 0.05$; chi-square) (Appendix 10), indicating that predators biased the CWT loss estimate by removing CWTs embedded in the eye or surrounding tissue. A significant difference ($p < 0.05$) was also noted between fresh (19.0%) and decomposed (44.7%) carcasses, and between carcasses with complete or partial (12.7%) and questionable (54.9%) AFCs (Appendix 10). When carcasses in the rotten, eye missing and questionable AFC categories were removed from the sample, the adjusted long term CWT loss was 8.8%. No difference ($p > 0.05$; chi-square) in CWT loss was noted between the study streams or between sexes (Appendix 9).

SAMPLING SELECTIVITY

Period

Temporal bias in the application sample was examined by comparing mark incidences in

Table 2. Disk tag application and recovery of Salmon River system coho adults, by release condition, 1993-1994.

Category	Release condition	Disk tags applied	Disk tags recovered	Percent recovered
Swimming performance	Normal	430	71	16.5%
	Required ventilation	60	13	21.7%
Body bruising a	None visible	219	36	16.4%
	Present	270	47	17.4%

a. Excludes 1 disk tag recovery for which bruising was not recorded.

Table 3. Incidence of disk tags or secondary marks in coho adults recovered on the Salmon River system spawning grounds, by recovery period and sex, 1993-1994.

	Recovered with disk tag or secondary mark			Total recovery			Mark incidence		
Recovery period	Male	Female	Total	Male	Female	Total	Male	Female	Total
10-Nov to 16-Dec	13	5	18	72	57	129	18.1%	8.8%	14.0%
17-Dec to 03-Jan	14	21	35	214	276	490	6.5%	7.6%	7.1%
04-Jan to 21-Jan	16	15	31	204	220	427 a	7.8%	6.8%	7.3%

a. Includes 3 of unknown sex.

Table 4. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application period and sex, 1993-1994.

	Disk tags and secondary mark applied a			Carcasses recovered with disk tags			Percent recovered		
Application period	Male	Female	Total	Male	Female	Total	Male	Female	Total
27-Oct to 14-Nov	44	21	65	5	1	6	11.4%	4.8%	9.2%
15-Nov to 30-Nov	148	116	264	22	20	42	14.9%	17.2%	15.9%
01-Dec to 20-Dec	89	72	161	16	20	36	18.0%	27.8%	22.4%

a. Corrected for sex identification error.

Table 5. Proportion of the Salmon River system coho adult spawning ground recovery sample marked with disk tags or secondary marks, by recovery section and sex, 1993-1994.

Location	Recovery section a	Carcasses recovered with disk tags or secondary marks			Coho adult carcasses examined b			Mark incidence		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Salmon River	Lower	13	14	27	60	58	118	21.7%	24.1%	22.9%
	Middle	4	8	12	69	71	141 b	5.8%	11.3%	8.5%
	Upper	1	2	3	107	152	259	0.9%	1.3%	1.2%
Coghlan Creek	Lower	14	7	21	116	105	221	12.1%	6.7%	9.5%
	Upper	11	10	21	138	167	307 c	8.0%	6.0%	6.8%

a. Salmon River: lower - S1, S2; middle - S3; upper - S4, S5.
Coghlan Creek: lower - C1; upper - C2, C3, C4, C5.

b. Includes 1 of unknown sex.

c. Includes 2 of unknown sex.

Table 6. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application section and sex, 1993-1994.

Location	Application section b	Disk tags applied a			Carcasses recovered with disk tags or secondary marks			Percent recovered		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Salmon River	Lower	127	95	222	15	14	29	11.8%	14.7%	13.1%
	Middle	41	35	76	6	10	16	14.6%	28.6%	21.1%
	Upper	28	16	44	3	3	6	10.7%	18.8%	13.6%
Coghlan Creek	Lower	58	44	102	9	6	15	15.5%	13.6%	14.7%
	Upper	28	18	46	10	8	18	35.7%	44.4%	39.1%

a. Corrected for sex identification error.

b. Salmon River: lower - S1, S2; middle - S3; upper - S4, S5.
Coghlan Creek: lower - C1; upper - C2, C3, C4, C5.

three recovery periods (Table 3). Mark incidences ranged from 6.5% to 18.1%, but the differences were significant ($p < 0.05$; chi-square) only in males. The highest mark incidences occurred in the early recovery period.

Recovery bias was examined by comparing the proportions recovered from three application periods (Table 4). The proportions ranged from 4.8% to 27.8%, but the differences were not significant ($p > 0.05$) in either sex.

Location

Spatial bias in the application sample was examined by comparing the mark incidences in five recovery sections (Table 5). Mark incidence ranged from 0.9% to 24.1%; the differences were

Table 7. Proportion of the Salmon River system coho adult disk tag application sample recovered on the spawning grounds, by 10 cm increments of nose-fork length and sex, 1993-1994.

Nose-fork length (cm)	Disk tags applied a			Carcasses recovered with disk tags or secondary marks			Percent recovered		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
30-39.9	8	0	8	0	0	0	0.0%	-	0.0%
40-49.9	92	31	123	14	4	18	15.2%	12.9%	14.6%
50-59.9	155	168	323	24	32	56	15.5%	19.0%	17.3%
60-69.9	27	8	35	5	5	10	18.5%	62.5%	28.6%
70-79.9	0	1	1	0	0	0	-	0.0%	0.0%

a. Corrected for sex identification error.

Table 8. Sex composition of Salmon River system coho adults in the disk tag application and spawning ground recovery samples, 1993-1994.

Sex	Application sample sex ratio, by recovery status a				Recovery sample sex ratio, by mark status			
	Sample size	Recovered	Not recovered	Total	Sample size	Marked	Unmarked	Total
Male	283	51.2%	59.1%	57.8%	490	51.2%	46.6%	47.0%
Female	207	48.8%	40.9%	42.2%	553	48.8%	53.4%	53.0%

a. Corrected for sex identification error.

Table 9. Results of the statistical tests for bias in the 1993-1994 Salmon River system coho adult escapement estimation study. a

Bias type	Application sample	Recovery sample
Statistical	-	No bias
Release condition	No bias	-
Period	Males biased to early period	No bias
Location	Both sexes biased to lower Salmon	No bias
Fish size	No bias	Possible bias to large females
Fish sex	No bias	No bias

a. A "no bias" test result indicates that bias was not detected; undetected biases may be present.

Table 10. Escapement estimates and 95% confidence limits, by sex and age, for Salmon River system coho adults, 1993-1994.

Group	Escapement by age			95% confidence limits on escapement estimate	
	3/2	4/3	Total	Lower	Upper
Male	3,133	36	3,169	2,286	4,053
Female	2,648	96	2,744	1,955	3,532
Total	5,781	132	5,913	4,729	7,097

significant ($p < 0.05$; chi-square) in both sexes. The mark incidences were highest in the lower sections of Salmon River.

Recovery bias was examined by stratifying the application sample into five sections and comparing the proportions recovered (Table 6). The proportions ranged from 10.7% to 44.4%; however, the differences were not significant ($p > 0.05$) in either sex.

Fish Size

Size related bias in the application sample was examined by comparing POH length-frequency distributions of marked and unmarked spawning ground recoveries. No significant difference ($p > 0.05$; Kolmogorov-Smirnov two-sample test) was noted in males or females.

Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing NF length-frequency distributions of each. No significant difference ($p > 0.05$) was noted; however, when the data were stratified by 10 cm increments of nose-fork length, larger females were recovered at a significantly higher rate (Table 7).

Fish Sex

No significant difference ($p > 0.05$; chi-square) was noted in the sex ratio of marked and unmarked spawning ground recoveries (Table 8). The application sample, therefore, was relatively unbiased with respect to sex.

No significant difference ($p > 0.05$) was noted in the sex ratio of the recovered and non-recovered components of the application sample Table 8). Furthermore, no difference was noted in the proportion of males (14.8%) and females (19.8%) released with disk tags and recovered on the spawning grounds (Table 1). We concluded, therefore, that the recovery sample was relatively unbiased with respect to sex.

Spawning Success

Spawning success, estimated from the internal examination of female spawning ground recoveries, was estimated at 96.9% (Appendix 11). Spawning success of marked (94.9%) and unmarked (97.4%) females was not significantly different ($p > 0.05$; difference in proportions test).

ESTIMATION OF SPAWNER POPULATION

Total Escapement

Because serious spatial and temporal biases were not identified in this study (Table 9; see Discussion), escapement was calculated using the simple Petersen estimator. The 1993-1994 escapement of Salmon River coho adults was 5,913 (Table 10), with lower and upper 95% confidence limits of 4,729 and 7,097, respectively. The escapement of male and female coho adults was 3,169 and 2,744, respectively. Age 3_2 fish dominated the adult escapement (97.8%); only 2.2% were age 4_3.

The total escapement was allocated between the Salmon River and Coghlan Creek by applying proportions calculated from the Schaefer

Table 11. Smolt releases, adult escapement and survival to adult escapement, by location and CWT code, of 1990 brood Salmon River system coho salmon.

Location		CWT code 02 09 19	CWT code 02 09 20	CWT code 02 09 21	Adult escapement with an AFC but without a CWT
Salmon River	Number of smolts released a	-	9,681	4,787	-
	Spawning ground recoveries				
	Number	9	31	27	-
	Percent by code	13.4%	46.3%	40.3%	-
	Escapement b	80	276	240	58
Coghlan Creek	Number of smolts released a	9,336	-	4,337	-
	Spawning ground recoveries				
	Number	44	4	25	-
	Percent by code	60.3%	5.5%	34.2%	-
	Escapement b	291	26	166	47
Total	Escapement	371	302	406	105
	Survival to escapement	4.0%	3.1%	4.4%	-

a. Adjusted for long term CWT loss.

b. Product of the stream-specific escapement, pooled AFC incidence, pooled CWT retention, and proportion by code.

stratified estimate. The Salmon River accounted for 55.2% (3,363) of the total escapement, 57.2% (1,813) of the adult male escapement and 52.8% (1,449) of the female escapement.

Adipose Fin Clips and Coded Wire Tags

The AFC incidences in the Salmon River (20.7%) and Coghlan Creek (19.4%) were not significantly different ($p > 0.05$; chi-square). The AFC escapement, therefore, was derived from the pooled AFC incidence of 20.0%. The AFC escapement was 1,184 adults, with lower and upper 95% confidence limits of 942 and 1,427, respectively. The AFC escapement by stream was the product of the Petersen estimate for the entire system and the ratio of the stream specific Schaefer estimates. Of the estimated 1,184 coho adult AFC escapement, 654 returned to the Salmon River and 530 to Coghlan Creek (Table 11). Of that total, 371 returned with code 02 09 19, 302 with code 02 09 20, 406 with code 02 09 21, and 105 (8.8%) had lost the CWT. Survival from smolt release to adult escapement averaged 3.8%. There was a significant difference ($p < 0.5$; chi-square) in survival between the single site releases in Salmon River (3.1%) and Coghlan Creek (4.0%) and between the early (3.5%) and late (4.4%) mixed site releases.

DISCUSSION

PROGRAM EFFECTIVENESS

The effectiveness of the 1990 brood juvenile program can be evaluated by examining the number of smolts trapped and the AFC incidence in the subsequent adult escapement. Both the 1990 brood release of coded wire tagged coho smolts (28,141) and the subsequent adult AFC incidence (20.0%) were considerably higher than the previous six year average of 21,547 and 14.7%, respectively (Farwell *et al.* 1992b; Schubert *et al.* 1994). This suggests that the efficiency of the 1992 trapping program was high and that smolt production remained low. The former is surprising because the traps were inoperative for seven days during the peak of migration. The latter is supported by a smolt production index calculated for the 1984-1990 brood years (Table 12). The index represents simple Petersen estimates, scaled by a factor of 10^{-5}, using fin clipped smolts as the mark application sample and the adult recovery as the census sa-

Table 12. Trends in smolt production, smolt to adult survival, exploitation rate and escapement of coded wire tagged 1984-1990 brood Salmon River system coho salmon.

Dominant brood year	Smolts released with CWTs	Smolt production index	Fishery CWT harvest a	Adult CWT escapement b	Total survival	Exploitation rate	Adult escapement in brood year + 3
1984	7,891	2.94	805	373 c	14.9%	68.3%	11,947
1985	20,022	1.60	3,133	1,102	21.2%	74.0%	9,152
1986	24,634	2.39	2,065	903	12.0%	69.6%	8,427
1987	26,911	1.69	2,609	801	12.7%	76.5%	4,942 d
1988	20,390	2.13	1,077	371	7.1%	74.4%	4,321
1989	29,435	1.15	1,903	730	8.9%	72.3%	2,604
1990	28,141	1.52	e	1,079	e	e	5,913

a. Primarily age 3, but may include a small age 2 or age 4 component; does not include river Indian or sport fisheries.

b. Recalculated from Farwell et al. (1992) using AFC incidence stratified by stream.

c. Includes 57 which were recovered in 1988 at age 4.

d. Recalculated from Farwell et al. (1991) to correct an error in the mark-recapture data.

e. Currently unavailable; will be provided in next year's report.

sample. The estimates are expressed as an index because capture and tagging probably reduced the smolt to adult survival, introducing an unquantifiable positive bias in the population estimates. Despite this bias, however, the data were useful as an index of gross changes in annual smolt production because survival impacts were unidirectional and likely to have been relatively consistent from year to year. The 1990 brood smolt index of 1.52 was above the the 1989 brood index of 1.15 but was well below the 1984-1989 brood average of 1.98.

The effectiveness of the 1990 brood adult program was evaluated by calculating the proportion of the population which was handled during tag application and carcass recovery. Tags were applied to 8.3% of the population, slightly below the study period average of 8.5% (Table 13). The proportion of the escapement censused (17.7%) and of the marks recovered (17.1%) were also slightly below the study period averages of 19.4% and 20.0%, respectively. These results indicate that the 1993-1994 program performance was about average for this study.

MARK-RECAPTURE STUDY

Population estimates derived from mark-recapture studies are susceptible to bias from a number of sources, including: tag loss; physiological stress which can induce the emigration of tagged fish from the population or alter recapture vulnerability; and nonrepresentative tag application or recovery resulting from samples which are selective by fish size, sex or spatial and temporal run component. We evaluated the effect of capture and tagging on subsequent catchability and concluded that this assumption was not seriously violated in 1993-1994. Electroshocker induced bruising did not significantly influence subsequent catchability or survival. This is in contrast to the results of the 1992-1993 study (Schubert *et al.*) where bruising was positively correlated with subsequent catchability. This result suggests that this year's field settings of electroshocker current were adequate to stun the fish without significantly influencing subsequent behaviour. The similar spawning success of marked and unmarked females further supports this conclusion.

It was not possible to definitively test the representativeness of the application and recovery samples because the true population parameters were not known. Instead, we examined the samples for four biases, temporal, spatial, fish size and fish sex, as indicators of weakness in the study design. Spatial, temporal and, potentially, size biases were identified in the current

study (Table 9); however, similar biases were not present in both the application and recovery samples. Junge (1963) noted that, when nonrepresentative sampling occurs, accurate results may still be achieved if one sample is representative. Because we had no reason to believe that the samples were similarly biased, we concluded that the identified biases were unlikely to have introduced bias in the escapement estimate. We tested this assumption by calculating population estimates which were spatially and temporally stratified using Schaefer's and Darroch's techniques. These estimates differed from the simple Petersen estimate by less than 3%.

STOCK STATUS

The status of the Salmon River system coho salmon stock can be inferred from trends in adult escapement, smolt production, exploitation rate and smolt to adult survival (Fig. 2). In an evaluation of stock status through the 1989 brood year, Schubert *et al.* (1994) noted that an escapement collapse had occurred during a period of reduced smolt production and smolt to adult survival. They concluded that exploitation rates must be reduced for this stock to rebuild. A full reassessment of stock status based on 1990 brood year data cannot be completed because harvest data are currently unavailable; however, inferences can be made based on additional escapement and smolt production data. Escapement increased for the first time following five consecutive years of declines, but remained well below the study period average escapement. Smolt production, as indicated by the smolt production index, also increased from the record low index for the 1989 brood year; however, the trend in erosion of smolt production noted by Schubert *et al.* (1994) does not appear to have been halted. Until harvest data become available, we are unable to identify the reason for the improved escapement in 1993-1994, whether increased smolt production, increased smolt to adult survival, or decreased exploitation rate. Based on the available data, however, we have no reason to revise the conclusions reached by the previous stock status assessment.

SUMMARY

1. The Salmon River (Langley) supports one of a group of B.C. coho stocks being monitored for responses to management actions by measuring annual escapement, marine survival, harvest distribution and exploitation rate. This report documents the 1990 brood year results.

2. Coded wire tags (CWTs) and adipose fin clips (AFCs) were applied to emigrant smolts at fence traps in Salmon River and Coghlan Creek, the principal tributary, from April 16 to June 1, 1992. Tagged smolts were transported and released below a pumphouse at the river mouth.

3. A total of 28,141 coho smolts were released with CWTs and AFCs. Size averaged 91.5 mm nose-fork length and 7.8 g wet weight.

4. Adult spawners were enumerated by a mark-recapture study from October 27, 1993 to January 21, 1994. Coho adults were captured using an electroshocker and marked with disk tags and opercular punches. Escapement was censused by the recovery of carcasses following spawning.

5. The 1993-1994 coho adult escapement was estimated from a tag application sample of 490, a recovery sample of 1,046, and a recovery of 84 tags or secondary marks. The escapement was estimated at 5,913 adults, of which 3,169 were male, 2,744 were female and 1,184 had AFCs. Long term CWT loss was 8.8%.

6. The proportion of the smolt release which returned to the spawning grounds was 3.8%. The proportion was higher in Coghlan Creek than in Salmon River, and higher among late releases.

7. Most (97.8%) of the adult escapement was age 3_2. Adult POH length averaged 43.9 cm for females and 41.4 cm for males.

8. Spatial and temporal biases in the application and recovery samples were identified during this study; however, they were considered unlikely to have biased the escapement estimate.

9. Increased escapement was observed for the first time in the seven year study period; however, the reasons for the increase will not be known until the harvest data are available for analysis.

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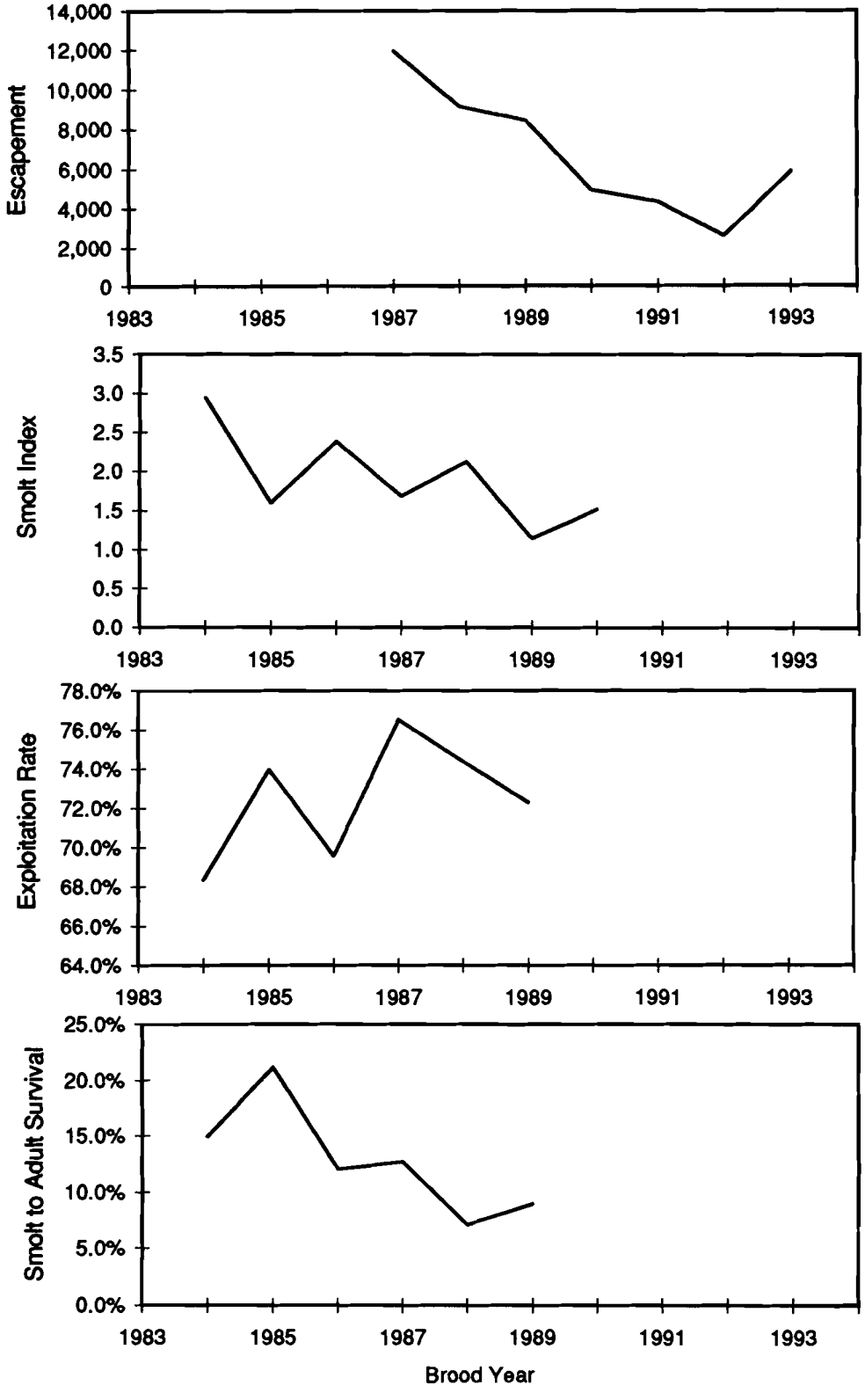

Fig. 2. Trends in adult escapement, smolt production, exploitation rate and total survival, by brood year, in 1984-1990 brood Salmon River coho salmon.

B. Widmer. Aging was performed under the supervision of C. Gosselin.

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APPENDICES

Appendix 1a. Daily enumeration of downstream migrants, by species, at the Salmon River fence trap, 1992.

Date	Water temp. (C) a	Water level (m) a	Coho smolt	Cutthroat trout		Rainbow trout		Lamprey	Sculpin	Stickle-back	Cray-fish	Sucker
				Smolt	Parr	Smolt	Parr					
19-Apr	9.0	-	10	0	0	2	0	2	0	0	0	0
20-Apr b	11.0	-	-	-	-	-	-	-	-	-	-	-
21-Apr	9.5	0.21	7	2	0	2	0	4	0	0	0	0
22-Apr	9.5	0.24	3	0	0	0	0	1	0	1	0	0
23-Apr	8.0	0.27	407	56	1	91	30	1	0	0	0	0
24-Apr	9.5	0.23	87	6	1	3	3	1	0	2	0	0
25-Apr	12.0	0.21	963	16	0	27	3	0	0	1	0	0
26-Apr	12.0	0.21	282	13	0	9	0	0	0	0	0	0
27-Apr	12.0	0.28	3,594	78	5	168	8	0	0	0	0	0
28-Apr	12.0	0.25	1,333	8	0	13	0	0	0	0	0	0
29-Apr c	-	0.66	57	0	0	0	0	0	0	0	0	0
30-Apr c	-	0.50	-	-	-	-	-	-	-	-	-	-
01-May c	-	0.38	-	-	-	-	-	-	-	-	-	-
02-May c	10.5	0.31	-	-	-	-	-	-	-	-	-	-
03-May c	10.0	0.27	-	-	-	-	-	-	-	-	-	-
04-May c	-	-	-	-	-	-	-	-	-	-	-	-
05-May c	13.0	0.24	-	-	-	-	-	-	-	-	-	-
06-May	12.5	0.24	2,033	5	5	6	6	3	8	2	0	0
07-May	13.0	0.23	435	2	0	0	0	0	0	0	0	0
08-May	12.5	0.20	1,370	27	5	13	1	1	0	0	0	0
09-May	12.0	0.22	148	8	1	2	1	1	0	0	0	0
10-May	10.5	0.25	521	107	56	67	23	0	0	0	0	0
11-May	10.0	0.24	81	28	6	4	0	0	0	0	0	0
12-May	8.5	0.22	338	46	2	11	0	0	0	0	0	0
13-May	9.0	0.21	428	57	5	16	0	1	0	2	0	0
14-May	10.0	0.20	529	46	5	11	0	1	0	0	0	0
15-May	10.5	0.22	1,146	71	5	7	0	0	1	0	0	0
16-May	12.0	0.21	951	100	11	20	4	0	0	0	0	0
17-May	12.0	0.21	721	17	1	0	7	1	0	0	0	0
18-May	12.5	0.21	348	27	5	2	1	1	0	0	0	0
19-May	12.0	0.20	382	19	0	3	0	0	0	0	0	0
20-May	11.0	0.20	245	32	1	9	0	0	0	0	0	0
21-May	10.5	0.20	291	16	1	6	5	0	4	0	2	0
22-May	10.5	0.20	81	15	0	2	0	0	0	0	0	0
23-May	11.5	0.20	119	12	2	0	1	1	1	0	0	0
24-May	13.0	0.19	83	5	1	0	0	0	0	0	1	0
25-May	14.0	0.19	60	10	2	1	1	0	0	0	3	0
26-May	14.0	0.19	94	3	1	0	0	1	0	3	0	0
27-May	13.0	0.17	106	27	7	3	2	1	0	0	0	0
28-May	13.0	0.17	59	3	1	0	1	0	0	0	1	0
29-May	13.0	0.19	36	1	1	1	2	0	0	0	0	0
30-May	13.0	0.19	10	3	0	0	0	0	0	0	0	0
31-May	13.5	0.19	2	2	0	0	0	1	0	0	1	0
01-Jun	14.0	0.19	36	4	0	0	0	2	0	2	0	0
Total	-	-	17,396	872	131	499	99	24	14	13	8	0

a. Recorded at approximately 0845 hrs.

b. Trap not fishing due to dropping water level.

c. Trap out due to high water.

Appendix 1b. Daily enumeration of downstream migrants, by species, at the Coghlan Creek fence trap, 1992.

Date	Water temp. (C) a	Water level (m) a	Coho smolt	Cutthroat trout		Rainbow trout		Lamprey	Sculpin	Stickle-back	Cray-fish	Sucker
				Smolt	Parr	Smolt	Parr					
16-Apr	-	0.70	49	3	0	0	0	1	0	0	0	0
17-Apr	-	1.25	228	77	1	42	1	0	4	0	0	0
18-Apr b	-	1.18	-	-	-	-	-	-	-	-	-	-
19-Apr	8.5	0.81	155	66	1	34	0	0	0	0	0	0
20-Apr	9.5	0.74	171	60	11	28	0	0	1	1	1	0
21-Apr	8.5	0.69	284	37	0	10	0	0	0	0	1	0
22-Apr	8.5	0.89	218	22	0	2	0	0	1	0	2	0
23-Apr	8.0	0.84	523	64	2	17	0	0	0	0	1	0
24-Apr	9.0	0.75	434	12	0	5	0	0	0	0	0	0
25-Apr	11.5	0.69	339	8	0	2	0	0	0	0	0	0
26-Apr	11.0	0.70	392	51	0	18	0	0	0	0	2	0
27-Apr	11.5	1.03	1,504	29	4	16	3	1	2	0	3	0
28-Apr	11.0	0.82	1,010	98	6	11	2	0	2	0	1	0
29-Apr b	-	2.08	-	-	-	-	-	-	-	-	-	-
30-Apr b	-	1.35	-	-	-	-	-	-	-	-	-	-
01-May b	-	1.03	-	-	-	-	-	-	-	-	-	-
02-May b	10.0	0.90	-	-	-	-	-	-	-	-	-	-
03-May b	9.5	0.80	-	-	-	-	-	-	-	-	-	-
04-May b	-	-	-	-	-	-	-	-	-	-	-	-
05-May	12.0	0.72	74	0	0	0	0	2	0	0	2	0
06-May	11.0	0.73	2,876	16	0	3	0	0	0	0	1	0
07-May	11.0	0.69	996	28	3	1	2	1	0	2	5	0
08-May	11.0	0.68	1,741	148	13	6	2	0	0	0	0	0
09-May	10.0	0.70	829	36	2	2	1	1	0	0	0	0
10-May	10.0	0.82	717	225	6	11	2	0	0	0	1	0
11-May	9.0	0.72	450	52	3	3	0	2	0	0	2	0
12-May	8.0	0.72	304	12	0	0	0	0	0	0	1	0
13-May	9.0	0.69	342	37	1	3	0	0	0	2	1	0
14-May	9.0	0.68	450	21	4	3	0	0	0	0	0	0
15-May	9.5	0.68	565	85	4	5	0	0	0	0	0	0
16-May	10.5	0.66	619	116	5	7	5	0	0	0	0	0
17-May	10.5	0.66	386	45	1	5	1	0	0	0	1	0
18-May	11.0	0.64	335	64	3	2	1	0	0	2	1	0
19-May	11.0	0.65	244	22	3	0	0	0	0	0	0	0
20-May	10.0	0.63	173	40	4	1	0	0	1	1	0	0
21-May	9.5	0.66	139	25	2	1	1	0	0	0	1	0
22-May	9.5	0.63	108	47	1	2	1	1	0	1	0	0
23-May	10.5	0.61	137	41	4	0	1	1	0	1	1	0
24-May	11.0	0.62	106	44	1	4	2	0	0	1	0	0
25-May	12.0	0.62	110	46	3	3	4	0	0	0	0	0
26-May	12.0	0.62	81	22	1	0	5	0	0	1	0	0
27-May	11.0	0.59	82	30	1	2	2	0	0	0	0	0
28-May	12.0	0.60	36	26	1	0	1	1	0	0	2	0
29-May	11.5	0.63	46	31	3	5	4	1	0	0	2	0
30-May	11.0	0.62	22	26	2	1	2	0	0	0	0	0
31-May	12.0	0.62	23	6	2	0	1	0	0	0	1	0
01-Jun	12.0	0.61	13	9	1	0	1	0	0	0	1	0
Total	-	-	17,311	1,827	99	255	45	12	11	12	34	0

a. Recorded at approximately 0830 hrs.

b. Trap out due to high water.

Appendix 2a. Application of coded wire tags, by code and date, to Salmon River coho salmon smolts, 1992.

CWT code	Tagging date	Maximum holding time (days)	Pre-tagging mort-ality	Total number marked	24 hour CWT rejection		Post tagging mortality		Total released with CWTs c
					N a	(%)	Immediate	24-hour b	
02/09/20	22-Apr	0	0	15	15	0.0	0	0	14
	23-Apr	0	7	400	147	2.0	0	0	358
	24-Apr	0	0	84	84	2.4	0	0	74
	26-Apr	2	1	3,396	198	1.5	0	0	3,049
	27-Apr	0	8	1,459	213	0.0	2	14	1,314
	01-May	4	0	379	176	0.0	0	0	344
	02-May	5	0	999	241	0.0	0	0	908
	06-May	0	2	2,024	195	1.0	0	0	1,827
	07-May	0	0	435	435	0.0	0	0	397
	08-May	0	1	1,367	109	2.8	0	0	1,212
	11-May	0	0	202	202	0.0	0	0	184
Total (mean)		(1.0)	19	10,760	2,015	(0.6)	2	14	9,681
02/09/21	11-May	0	3	1,231	187	3.2	0	0	1,086
	12-May	0	0	336	336	0.0	0	0	306
	13-May	0	1	425	179	0.3	0	0	387
	14-May	0	1	527	123	0.2	0	0	480
	15-May	0	3	1,143	179	0.0	0	0	1,042
	19-May	3	2	1,031	341	6.2	0	0	882
	21-May	0	0	290	242	0.8	0	0	262
	25-May	3	0	203	203	2.9	0	0	180
	26-May	0	0	94	94	0.0	0	0	86
	29-May	3	0	36	36	0.0	0	0	33
	01-Jun	4	0	47	47	0.0	0	0	43
	Total (mean)	(1.2)	10	5,363	1,967	(1.8)	0	0	4,787
Total (mean)		(1.1)	29	16,123	3,982	(1.2)	2	14	14,468

a. Sample size held to assess tag loss.

b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.

c. Adjusted for long term CWT loss (see text).

Appendix 2b. Application of coded wire tags, by code and date, to Coghlan Creek coho salmon smolts, 1992.

CWT code	Tagging date	Maximum holding time (days)	Pre-tagging mort-ality	Total number marked	24 hour CWT rejection		Post tagging mortality		Total released with CWTs c
					N a	(%)	Immediate	24-hour b	
02/09/19	21-Apr	4	2	173	173	0.6	3	3	151
	22-Apr	0	5	917	132	1.5	2	14	808
	23-Apr	0	0	470	275	3.3	17	29	373
	24-Apr	0	0	432	217	1.4	1	2	386
	28-Apr	4	1	2,208	213	0.0	1	10	2,003
	01-May	5	0	1,007	309	0.3	0	0	915
	06-May	0	0	765	195	1.0	0	0	690
	07-May	0	0	2,097	197	0.4	2	21	1,884
	08-May	0	0	1,726	144	1.4	2	24	1,529
	11-May	0	0	666	181	1.7	0	0	597
Total (mean)		(1.3)	8	10,461	2,036	(1.2)	28	104	9,336
02/09/21	11-May	0	0	997	181	1.7	0	0	894
	12-May	0	0	302	288	2.1	0	0	270
	13-May	0	0	341	280	1.0	0	0	308
	14-May	0	0	447	132	0.0	0	0	407
	15-May	0	0	563	223	0.0	0	0	513
	19-May	2	0	1,586	301	0.7	0	0	1,437
	21-May	0	0	137	136	0.0	0	0	125
	24-May	0	0	245	203	1.0	0	0	221
	25-May	0	0	80	80	0.0	2	2	69
	28-May	3	0	45	45	0.0	0	0	41
	01-Jun	0	0	57	57	0.0	0	0	52
	Total (mean)	(0.5)	0	4,800	1,926	(0.8)	2	2	4,337
Total (mean)		(0.9)	8	15,261	3,962	(1.0)	30	106	13,673

a. Sample size held to assess tag loss.

b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.

c. Adjusted for long term CWT loss (see text).

Appendix 3. Anomalies encountered while coded wire tagging wild Salmon River system coho salmon smolts, 1992.

Location	Number inspected	Fog eye	Neascus	Scoliosis	Fin rot	Naturally missing adipose fin
Salmon River	16,094	2,403	26	4	23	4
		14.9%	0.16%	0.02%	0.14%	0.02%
Coghlan Creek	15,253	2,019	8	13	52	3
		13.2%	0.05%	0.09%	0.34%	0.02%
Total	31,347	4,422	34	17	75	7
		14.1%	0.11%	0.05%	0.24%	0.02%

Appendix 4. Mean length and weight, by location and date, of coho salmon smolts in the Salmon River system, 1992.

Location	Sample date	Sample size	Nose-Fork length (mm) Mean	Nose-Fork length (mm) Standard deviation	Mean wet weight (g)
Salmon River	23-Apr	50	95.1	15.8	9.3
	28-Apr	50	94.3	12.3	8.2
	06-May	50	92.0	10.6	8.3
	08-May	50	90.5	9.8	7.5
	12-May	50	91.2	12.6	8.3
	18-May	50	84.6	9.1	6.6
	22-May	50	84.6	7.5	6.5
	26-May	50	83.5	5.4	5.9
	29-May	36	81.0	6.0	5.6
	Total	436	90.0 a	-	7.5 a
Coghlan Creek	23-Apr	50	102.2	12.9	11.3
	28-Apr	50	96.9	11.7	7.8
	05-May	50	94.6	9.1	9.0
	08-May	50	91.0	8.0	8.0
	12-May	50	91.0	7.7	8.0
	15-May	50	89.5	5.8	7.5
	18-May	50	90.4	7.5	7.7
	22-May	50	89.6	5.8	7.3
	26-May	50	87.5	6.9	7.1
	29-May	46	89.9	12.4	7.8
	Total	496	93.0 a	-	8.1 a
Total	-	932	91.5 a	-	7.8 a

a. Weighted by proportion of smolt migration in time periods.

Appendix 5a. Daily application of disk tags and secondary marks, by reach, release condition, adipose fin status and sex, to coho adults in the Salmon River, 1993-1994. a

		Released unbruised			Released with electroshocker bruising			Total			Adipose absent c	
Date	Reach b	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
27-Oct	S1	5	3	8	9	1	10	14	4	18	4	1
	S2	0	0	0	3	0	3	3	0	3	1	0
28-Oct	S1	0	1	1	2	2	4	2	3	5	0	0
1-Nov	S1	4	3	7	6	2	8	10	5	15	2	1
	S2	1	0	1	0	0	0	1	0	1	0	0
3-Nov	S1	1	1	2	3	1	4	4	2	6	0	0
	S2	0	0	0	1	0	1	1	0	1	0	0
4-Nov	S1	1	0	1	0	1	1	1	1	2	0	1
8-Nov	S1	0	3	3	4	0	4	4	3	7	1	0
15-Nov	S1	3	0	3	1	0	1	4	0	4	1	0
17-Nov	S2	0	0	0	2	1	3	2	1	3	0	0
	S3	4	2	6	7	0	7	11	2	13	2	1
18-Nov	S1	1	0	1	4	1	5	5	1	6	0	0
22-Nov	S1	17	10	27	15	9	24	32	19	51	2	2
29-Nov	S1	22	17	39	20	27	47	42	44	86	7	9
	S2	1	2	3	4	7	11	5	9	14	0	0
1-Dec	S3	4	3	7	15	7	22	19	10	29	3	1
	S4	3	3	6	9	2	11	12	5	17	2	2
2-Dec	S5	1	2	3	7	2	9	8	4	12	2	1
13-Dec	S4	5	3	8	3	4	7	8	7	15	1	1
20-Dec	S3	6	14	20	6	8	14	12	22	34	2	3
Total	S1	54	38	92	64	44	108	118	82	200	17	14
	S2	2	2	4	10	8	18	12	10	22	1	0
	S3	14	19	33	28	15	43	42	34	76	7	5
	S4	8	6	14	12	6	18	20	12	32	3	3
	S5	1	2	3	7	2	9	8	4	12	2	1
Total	-	79	67	146	121	75	196	200	142	342	30	23

a. Not corrected for sex identification errors.

b. Salmon River reaches: S1 - below Coghlan Creek. S2 - Coghlan Creek to 64 Ave. S3 - 64 Ave. to 56 Ave. S4 - 56 Ave. to 248 St. S5 - 248 St. to 256 St.

c. Included in 'Total' column.

Appendix 5b. Daily application of disk tags and secondary marks, by reach, release condition, adipose fin status and sex, to coho adults in Coghlan Creek, 1993-1994. a

		Released unbruised			Released with electroshocker bruising			Total			Adipose absent c	
Date	Reach b	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
28-Oct	C1	0	1	1	1	0	1	1	1	2	0	0
8-Nov	C1	1	1	2	3	0	3	4	1	5	1	0
15-Nov	C1	2	1	3	2	1	3	4	2	6	1	0
17-Nov	C1	1	0	1	3	0	3	4	0	4	0	0
24-Nov	C1	19	25	44	24	9	33	43	34	77	9	6
2-Dec	C2	2	1	3	6	3	9	8	4	12	2	0
	C3	0	0	0	1	0	1	1	0	1	0	0
	C5	2	2	4	4	1	5	6	3	9	0	2
8-Dec	C2	2	3	5	3	0	3	5	3	8	1	1
9-Dec	C1	0	4	4	3	1	4	3	5	8	0	0
13-Dec	C2	4	2	6	5	4	9	9	6	15	2	0
	C3	0	0	0	0	1	1	0	1	1	0	0
Total	C1	23	32	55	36	11	47	59	43	102	11	6
	C2	8	6	14	14	7	21	22	13	35	5	1
	C3	0	0	0	1	1	2	1	1	2	0	0
	C4	0	0	0	0	0	0	0	0	0	0	0
	C5	2	2	4	4	1	5	6	3	9	0	2
	Total	33	40	73	55	20	75	88	60	148	16	9

a. Not corrected for sex identification error.

b. Coghlan Creek reaches: C1 - Salmon River to Hwy. 1. C4 - 64 Ave. to 256 St.
C2 - Hwy. 1 to 248 St. C5 - Above 256 St.
C3 - 248 St. to 64 Ave.

c. Included in 'Total' column.

Appendix 6. Disk tag and secondary mark recoveries, by application and recovery date and location, size, sex, adipose fin status and disk tag number, of coho salmon adults released in the Salmon River system, 1993-1994.

Application sample						Recovery sample					
Date	Reach	NF length (cm)	Sex	Adipose fin	Disk tag number	Date	Reach	POH length (cm)	Sex	Age	Days out
27-Oct	S2	53.7	M	A	21001	22-Dec	S2	43.0	M	R c	56
27-Oct	S1	53.0	F	P	21005	18-Nov	S1	-	F	3/2 e	22
27-Oct	S1	63.0	M	A	21009	15-Dec	S1	47.0	M	R c	49
27-Oct	S1	42.5	M	A	21010	15-Dec	S1	32.0	M	R c	49
8-Nov	S1	41.0	M	A	21055	20-Jan	C1	-	M	- c,e	73
8-Nov	C1	46.0	M	P	21062	10-Nov	C1	35.0	M	3/2 b,c	2
15-Nov	S1	60.5	M	A	21068	15-Dec	C2	49.0	M	- c	30
15-Nov	C1	52.0	M	P	21073	25-Nov	C1	37.0	M	3/2 c	10
15-Nov	C1	64.0	M	P	21074	6-Dec	C1	44.5	M	3/2 c	21
17-Nov	S3	61.5	M	P	21078	15-Dec	C1	46.0	M	- c	28
17-Nov	S3	48.0	M	A	21081	28-Dec	S1	36.5	M	3/2 c	41
17-Nov	S3	57.0	M	P	21087	22-Dec	S3	44.0	M	3/2 b,c	35
17-Nov	S3	56.5	F	A	21089	5-Jan	S1	45.0	F	R	49
22-Nov	S1	47.0	F	P	21108	10-Jan	S3	37.7	F	3/2	49
22-Nov	S1	57.0	M	P	21109	15-Dec	S1	45.0	F	R a,b	23
22-Nov	S1	53.0	M	P	21118	22-Dec	C1	40.6	M	3/2	30
22-Nov	S1	56.0	F	P	21122	22-Dec	S3	43.0	F	3/2	30
22-Nov	S1	57.0	F	P	21125	5-Jan	C1	45.5	F	3/2 c	44
22-Nov	S1	59.0	M	P	21147	20-Jan	S1	46.7	M	- c	59
22-Nov	S1	51.0	M	P	21150	29-Dec	S4	41.0	M	3/2	37
24-Nov	C1	61.0	F	P	21170	15-Dec	S1	48.0	F	3/2 c	21
24-Nov	C1	61.0	F	P	21173	15-Dec	C1	48.0	F	-	21
24-Nov	C1	45.0	M	P	21176	6-Dec	S1	34.0	M	3/2	12
24-Nov	C1	41.5	M	A	21181	22-Dec	C1	32.7	M	3/2 c	28
24-Nov	C1	50.5	F	P	21188	5-Jan	S1	41.6	F	3/2 c	42
24-Nov	C1	57.5	F	P	21192	22-Dec	C2	47.0	F	3/2	28
24-Nov	C1	60.0	M	P	21198	6-Dec	C1	47.5	M	3/2	12
24-Nov	C1	55.5	M	A	21200	22-Dec	C2	-	M	3/2 b,c	28
24-Nov	C1	58.0	M	P	21208	25-Nov	C1	42.0	M	3/2 b	1
24-Nov	C1	51.5	F	A	21217	7-Jan	C2	42.5	F	R c	44
24-Nov	C1	51.0	F	P	21226	15-Dec	C1	42.0	F	-	21
24-Nov	C1	51.0	M	P	21227	5-Jan	C1	37.0	M	3/2	42
29-Nov	S1	41.0	M	P	21232	5-Jan	S1	33.8	M	R	37
29-Nov	S1	57.0	F	P	21255	22-Dec	S2	47.0	F	3/2 c	23
29-Nov	S1	56.0	F	P	21260	23-Dec	C3	45.7	F	3/2 c	24
29-Nov	S1	55.0	F	P	21263	5-Jan	S1	44.0	F	3/2 c	37
29-Nov	S1	60.5	F	P	21269	7-Jan	C2	50.1	F	3/2 c	39
29-Nov	S1	56.5	F	A	21274	5-Jan	C1	48.5	F	R c	37
29-Nov	S1	55.0	F	P	21276	10-Jan	S1	46.5	F	3/2 c	42
29-Nov	S1	48.5	M	P	21282	22-Dec	C1	40.5	M	R c	23
29-Nov	S1	50.0	M	P	21284	15-Dec	S1	39.0	M	3/2	16
29-Nov	S1	51.5	F	A	21295	5-Jan	C1	41.0	F	R	37
29-Nov	S1	53.0	M	P	21297	29-Dec	S2	41.4	M	R c	30
29-Nov	S1	53.0	M	P	21303	28-Dec	S1	42.0	M	3/2 c	29
29-Nov	S1	44.0	M	P	21304	10-Jan	C1	35.6	M	R	42
29-Nov	S1	50.0	M	A	21312	5-Jan	S1	39.2	M	3/2 b,c	37

Continued

Appendix 6. Disk tag and secondary mark recoveries, by application and recovery date and location, size, sex, adipose fin status and disk tag number, of coho salmon adults released in the Salmon River system, 1993-1994.

Application sample						Recovery sample					
Date	Reach	NF length (cm)	Sex	Adipose fin	Disk tag number	Date	Reach	POH length (cm)	Sex	Age	Days out
29-Nov	S1	60.0	F	P	21314	22-Dec	C1	46.6	F	R c	23
29-Nov	S2	57.0	F	P	21316	29-Dec	S4	46.0	F	3/2	30
1-Dec	S3	54.0	F	P	21332	22-Dec	S2	45.0	F	3/2 c	21
1-Dec	S3	56.5	M	P	21341	22-Dec	S2	42.0	M	R c	21
1-Dec	S3	58.0	F	P	21350	28-Dec	S1	48.5	F	R c	27
1-Dec	S3	54.0	M	P	21352	5-Jan	S3	43.1	M	R	35
1-Dec	S3	55.0	F	P	21356	21-Jan	S2	45.5	F	4/3 c	51
1-Dec	S4	50.5	F	A	21371	23-Dec	C4	39.3	F	3/2	22
2-Dec	C2	45.5	M	P	21376	5-Jan	C1	37.5	M	3/2 c	34
2-Dec	C2	52.0	F	P	21381	22-Dec	C2	44.0	F	3/2 b,c	20
2-Dec	C2	55.0	M	A	21383	15-Dec	C2	44.5	M	R b	13
2-Dec	C2	54.5	M	P	21384	15-Dec	C2	42.0	M	3/2 c	13
2-Dec	C2	54.0	M	A	21386	22-Dec	C2	42.0	M	R c	20
2-Dec	C5	52.5	F	P	21388	29-Dec	C5	43.0	F	R b	27
2-Dec	C5	54.0	F	A	21390	23-Dec	C4	43.2	F	R	21
2-Dec	S5	46.5	F	A	21403	29-Dec	S5	37.2	F	3/2 c	27
8-Dec	C2	53.0	F	A	21411	22-Dec	C1	46.2	F	R	14
8-Dec	C2	53.5	F	P	21416	22-Dec	S1	44.4	F	3/2	14
13-Dec	C2	57.0	M	P	21425	22-Dec	C2	43.0	M	3/2 b	9
13-Dec	C2	53.0	M	P	21429	7-Jan	C2	43.6	M	3/2	25
13-Dec	C2	64.0	F	P	21430	7-Jan	C2	53.8	F	3/2	25
13-Dec	C2	59.5	M	P	21431	21-Jan	C2	47.7	M	3/2 c	39
13-Dec	C2	46.5	M	A	21432	5-Jan	C2	39.5	M	R c	23
13-Dec	C2	57.5	M	P	21434	7-Jan	C2	47.4	M	3/2	25
13-Dec	C2	48.0	F	P	21436	22-Dec	C2	39.0	F	R b,c	9
13-Dec	C2	53.5	F	P	21438	22-Dec	S1	56.0	F	R c,f	9
13-Dec	C2	58.0	M	A	21439	22-Dec	C2	46.0	M	3/2 b	9
13-Dec	S4	49.5	M	P	21448	10-Jan	S3	-	M	3/2 c,e	28
13-Dec	S4	46.5	M	P	21450	5-Jan	C1	37.5	M	3/2 c	23
13-Dec	S4	43.5	M	P	21453	10-Jan	S3	35.1	M	3/2 c	28
13-Dec	S4	52.5	F	P	21454	10-Jan	S3	40.2	F	3/2 c	28
20-Dec	S3	52.0	F	A	21456	5-Jan	S2	44.2	F	R c	16
20-Dec	S3	56.0	F	P	21458	22-Dec	S3	48.0	F	3/2 b,c	2
20-Dec	S3	49.0	F	P	21462	22-Dec	S3	45.5	F	3/2	2
20-Dec	S3	58.5	F	P	21473	5-Jan	S3	47.8	F	R	16
20-Dec	S3	56.0	M	P	21474	5-Jan	S1	44.6	M	3/2 c	16
20-Dec	S3	57.0	F	P	21485	22-Dec	S3	-	F	R	2
20-Dec	S3	57.0	F	A	21488	22-Dec	S3	47.5	F	R	2

Mean days out: 25.7
Max. days out: 73.0
Min. days out: 0.0

Females initially identified as males: 1 2.4%
Males initially identified as females: 0 0.0%

POH and NF regressions:
Males: POH length = 0.69 NF length + 4.84
NF length = 1. 24 POH length + 1.80
Females: POH length = 0.77 NF length + 2.83
NF length = 1.01 POH length + 9.50

a. Incorrect sex identification during disk tag application
b. Required ventilation at release.
c. Bruised at release.
d. See Appendix 5 for reach descriptions.
e. Recovered without secondary mark.
f. Lengths excluded form regressions.

Appendix 7a. Daily coho carcass recoveries, by reach, mark status and sex, in the Salmon River, 1993-1994.

		Unmarked			Disk tag and secondary mark		Secondary mark only		Total			Adipose absent a		
Date	Reach	Male	Female	Jack	Male	Female	Male	Female	Male	Female	Jack	Male	Female	Jacks
10-Nov	S1	0	1	0	0	0	0	0	0	1	0	0	0	0
	S2	0	0	0	0	0	0	0	0	0	0	0	0	0
	S3	1	1	0	0	0	0	0	1	1	0	0	0	0
	S4	0	0	0	0	0	0	0	0	0	0	0	0	0
	S5	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	S1	1	2	0	0	1 b	0	0	1	3	0	1	0	0
22-Nov	S2	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	S3	1	0	0	0	0	0	0	1	0	0	1	0	0
6-Dec	S1	3	0	0	1	0	0	0	4	0	0	0	0	0
	S2	0	0	0	0	0	0	0	0	0	0	0	0	0
	S3	1	1	0	0	0	0	0	1	1	0	0	0	0
8-Dec	S4	0	0	0	0	0	0	0	0	0	0	0	0	0
	S5	0	1	0	0	0	0	0	0	1	0	0	0	0
15-Dec	S1	6	5	0	3	2	0	0	9	7	0	3	2	0
	S2	1	0	0	0	0	0	0	1	0	0	1	0	0
16-Dec	S3	5	4	0	0	0	0	0	5	4	0	0	3	0
	S4	6	5	0	0	0	0	0	6	5	0	0	1	0
	S5	0	0	0	0	0	0	0	0	1	0	0	0	0
22-Dec	S1	4	4	0	0	2	0	0	4	6	0	1	1	0
	S2	2	2	0	2	2	0	0	4	4	0	2	0	0
	S3	22	24	0	1	5	0	0	23	29	0	2	7	0
28-Dec	S1	14	10	0	2	1	0	0	16	11	0	3	4	0
29-Dec	S2	1	1	0	1	0	0	0	2	1	0	0	0	0
	S4	42	62	0	1	1	0	0	43	63	0	8	11	0
	S5	15	29	0	0	1	0	0	15	30	0	3	7	0
5-Jan	S1	5	4	0	3	3	0	0	8	7	0	3	2	0
	S2	0	2	0	0	1	0	0	0	3	0	0	1	0
	S3	10	8	0	1	1	0	0	12	9	0	2	1	0
7-Jan	S4	9	15	0	0	0	0	0	9	15	0	3	4	0
10-Jan	S1	3	6	0	0	1	0	0	3	7	0	0	0	0
	S2	0	1	0	0	0	0	0	0	1	0	0	0	0
	S3 c	12	18	0	2 b	2	0	0	14	20	0	3	7	0
18-Jan	S4	27	31	0	0	0	0	0	27	31	0	6	9	0
20-Jan	S1	5	4	0	1	0	0	0	6	4	0	0	1	0
	S5	7	6	0	0	0	0	0	7	6	0	0	0	0
21-Jan	S2	2	2	0	0	1	0	0	2	3	0	0	0	0
	S3	12	7	0	0	0	0	0	12	7	0	2	2	0
Total	S1	41	36	0	10	10 b	0	0	51	46	0	11	10	0
	S2	6	8	0	3	4	0	0	9	12	0	3	1	0
	S3 c	64	63	0	4 b	8	0	0	69	71	0	10	20	0
	S4	84	113	0	1	1	0	0	85	114	0	17	25	0
	S5	22	36	0	0	1	0	0	22	38	0	3	7	0
	Total	217	256	0	18	24	0	0	236	281	0	44	63	0

a. Included in 'Total' column.

b. Includes 1 chinook without secondary mark.

c. Excludes 1 unmarked chinook of unknown sex.

Appendix 7b. Daily coho carcass recoveries, by reach, mark status and sex, in the Coghlan Creek, 1993-1994.

		Unmarked			Disk tag and secondary mark		Secondary mark only		Total			Adipose absent a		
Date	Reach	Male	Female	Jack	Male	Female	Male	Female	Male	Female	Jack	Male	Female	Jacks
10-Nov	C1	0	2	0	1	0	0	0	1	2	0	0	0	0
	C2	0	0	0	0	0	0	0	0	0	0	0	0	0
	C3	0	0	0	0	0	0	0	0	0	0	0	0	0
	C4	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	C1	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	C1	1	0	0	2	0	0	0	3	0	0	0	0	0
	C2	1	0	0	0	0	0	0	1	0	0	0	0	0
6-Dec	C1	5	2	1	2	0	0	0	7	2	0	0	1	0
	C2	3	0	0	0	0	0	0	3	0	0	1	0	0
8-Dec	C3	0	0	0	0	0	0	0	0	0	0	0	0	0
	C4	1	0	0	0	0	0	0	0	0	0	0	0	0
	C5	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Dec	C1	11	15	0	1	2	0	0	12	17	0	0	4	0
	C2	8	4	0	3	0	0	0	11	4	0	5	0	0
16-Dec	C3	5	6	0	0	0	0	0	5	6	0	2	1	0
	C4	0	2	0	0	0	0	0	0	2	0	0	1	0
	C5	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Dec	C1	25	28	0	3	2	0	0	28	30	0	1	1	0
	C2	10	21	0	4	3	0	0	14	24	0	4	6	0
	C3	0	3	0	0	0	0	0	0	3	0	0	2	0
23-Dec	C3	16	19	1	0	1	0	0	16	20	1	3	3	0
	C4	20	15	0	0	2	0	0	20	17	0	5	9	0
29-Dec	C5	20	26	0	0	1	0	0	20	27	0	11	8	0
30-Dec	C2	8	7	0	0	0	0	0	8	7	0	1	1	0
	C3	1	4	0	0	0	0	0	1	4	0	0	0	0
4-Jan	C3	2	4	0	0	0	0	0	2	4	0	0	3	0
	C4	0	3	0	0	0	0	0	0	3	0	0	2	0
	C5	1	1	0	0	0	0	0	1	1	0	0	0	0
5-Jan	C1	27	24	0	3	3	0	0	30	27	0	1	2	0
	C2	3	3	0	1	0	0	0	3	3	0	1	0	0
7-Jan	C2	10	12	0	2	3	0	0	12	15	0	2	4	0
10-Jan	C1	21	4	0	1	0	0	0	22	4	0	2	0	0
12-Jan	C2	6	2	0	0	0	0	0	6	2	0	1	1	0
	C3	4	4	0	0	0	0	0	4	4	0	1	2	0
13-Jan	C4	1	2	0	0	0	0	0	1	2	0	0	0	0
	C5	1	2	0	0	0	0	0	1	2	0	0	1	0
20-Jan	C1	13	23	0	1 b	0	0	0	13	23	0	2	3	0
21-Jan	C2	5	11	0	1	0	0	0	6	11	0	1	1	0
	C3 c	3	6	0	0	0	0	0	3	6	0	0 d	1 d	0
Total	C1	103	98	1	14 b	7	0	0	116	105	0	6	11	0
	C2	54	60	0	11	6	0	0	64	66	0	16	13	0
	C3 c,d	31	46	1	0	1	0	0	31	47	1	6	12	0
	C4	22	22	0	0	2	0	0	21	24	0	5	12	0
	C5	22	29	0	0	1	0	0	22	30	0	11	9	0
	Total	232	255	2	25	17	0	0	254	272	1	44 d	57 d	0

a. Included in 'Total' column.
b. Includes 1 disk tag without a secondary mark.
c. Excludes 1 unmarked chinook of unknown sex.
d. Excludes 1 AFC chinook of unknown sex.

Appendix 8. Proportion at age and mean length at age, by location, AFC status and sex, of coho carcasses recovered on the Salmon River system spawning grounds, 1993-1994.

			Female			Male		
	Mark status	Age a	Sample size	Percent	Mean POH length (cm)	Sample size	Percent	Mean POH length (cm)
Salmon River	Unmarked	4/3	1	3.0%	45.5	0	0.0%	-
		3/2	32	97.0%	44.4	17	100.0%	42.4
		2/2	0	0.0%	-	0	0.0%	-
		Total	45	63.4%	44.8	26	36.6%	42.3
	Adipose fin clip	4/3	2	6.5%	42.0	1	4.3%	36.5
		3/2	29	93.5%	42.7	22	95.7%	40.3
		2/2	0	0.0%	-	0	0.0%	-
		Total	63	58.9%	42.9	44	41.1%	40.7
	Total	4/3	3	4.7%	43.2	1	2.5%	36.5
		3/2	61	95.3%	43.6	39	97.5%	41.2
		2/2	0	0.0%	-	0	0.0%	-
		Total	108	60.7%	43.7	70	39.3%	41.3
Coghlan Creek	Unmarked	4/3	0	0.0%	-	0	0.0%	-
		3/2	21	100.0%	45.5	25	100.0%	41.9
		2/2	0	0.0%	-	0	0.0%	-
		Total	32	48.5%	44.7	34	51.5%	41.6
	Adipose fin clip	4/3	1	3.3%	37.0	0	0.0%	-
		3/2	29	96.7%	43.6	23	100.0%	41.4
		2/2	0	0.0%	-	0	0.0%	-
		Total	57	56.4%	43.9	44	43.6%	41.3
	Total	4/3	1	2.0%	37.0	0	0.0%	-
		3/2	50	98.0%	44.4	48	100.0%	41.7
		2/2	0	0.0%	-	0	0.0%	-
		Total	89	53.0%	44.2	79 b	47.0%	41.5
Total	Unmarked	4/3	1	1.9%	45.5	0	0.0%	-
		3/2	53	98.1%	44.8	42	100.0%	42.1
		2/2	0	0.0%	-	0	0.0%	-
		Total	77	56.2%	44.8	60	43.8%	41.9
	Adipose fin clip	4/3	3	4.9%	40.4	1	2.2%	36.5
		3/2	58	95.1%	43.1	45	97.8%	40.9
		2/2	0	0.0%	-	0	0.0%	-
		Total	120	57.7%	43.3	88	42.3%	41.0
	Total	4/3	4	3.5%	41.7	1	1.1%	36.5
		3/2	111	96.5%	43.9	87	98.9%	41.5
		2/2	0	0.0%	-	0	0.0%	-
		Total	197	56.9%	43.9	149 b	43.1%	41.4

a. Totals include unageable samples.

b. Includes one with unknown adipose status.

Appendix 9. AFC and CWT sampling of coho salmon recovered on the Salmon River system spawning grounds, 1993-1994.

			Recovered in Salmon River				Recovered in Coghlan Creek				Total	
			Adult male	Adult female	Adult total	Jack	Adult male	Adult female	Adult total	Jack	Adult total	Jack
Sample size			236	281	517	0	254	272	527 a	1	1,044	1
Number with AFC's			44	63	107	0	44	57	102 a	0	209	0
- AFC but no head			6	9	15	0	3	5	9 a	0	24	0
- CWT lost during processing			0	0	0	0	0	0	0	0	0	0
- AFC but no CWT present			3	22	25	0	5	15	20	0	45	0
- CWT recovered:												
Code	*Brood*	*Release site*										
02 09 19	1990	Coghlan Creek	6	3	9	0	19	25	44	0	53	0
02 09 20	1990	Salmon River	13	18	31	0	3	1	4	0	35	0
02 09 21	1990	Both	16	11	27	0	14	11	25	0	52	0
Total			35	32	67	0	36	37	73	0	140	0
AFC incidence (%)			18.6%	22.4%	20.7%	-	17.3%	21.0%	19.4%	0.0%	20.0%	0.0%
CWT loss (%)			7.9%	40.7%	27.2%	-	12.2%	28.8%	21.5%	-	24.3%	-
Adjusted CWT loss (%) b			4.3%	21.4%	13.7%		7.1%	0.0%	3.9%	-	8.8%	-

a. Includes 1 of unknown sex.

b. See Results, Coded Wire Tag Recoveries section.

Appendix 10. Incidence of CWT loss, by carcass condition, eye status, and AFC condition, in AFC coho carcasses recovered on the Salmon River system spawning grounds, 1993-1994.

Observation	Condition	Number of AFC carcasses	CWT status unknown a	CWT absent	CWT loss (%)
Carcass condtion	Fresh	67	3	7	10.9%
	Moderately fresh	90	7	21	25.3%
	Moderately rotten	34	5	11	37.9%
	Rotten	18	9	6	66.7%
	Not recorded	0	0	0	-
Eyes	Both present	142	9	24	18.0%
	One or both absent	65	14	21	41.2%
	Not recorded	2	1	0	0.0%
Adipose fin clip	Complete	127	10	11	9.4%
	Partial	17	0	6	35.3%
	Questionable	65	14	28	54.9%
	Not recorded	0	0	0	-

a. Either a carcass with no head or the head was lost during processing.

Appendix 11. Spawning success in female coho carcasses recovered on the Salmon River system spawning grounds, 1993-1994.

Mark status		Percent spawned			
		0%	50%	100%	Weighted mean
Disk tag or secondary mark	Number	2	0	37	
	Percent	5.1%	0.0%	94.9%	94.9%
Unmarked	Number	3	2	150	
	Percent	1.9%	1.3%	96.8%	97.4%
Total	Number	5	2	187	
	Percent	2.6%	1.0%	96.4%	96.9%