Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2373

1996

ESCAPEMENT ENUMERATION STUDIES OF ADULT COHO SALMON AT ZOLZAP CREEK, B.C., 1993

prepared by

Bryan L. Nass

LGL Limited
environmental research associates[1]

for the

Nisga'a Tribal Council[2]

---

[1] 9768 Second St., Sidney, BC V8L 3Y8

[2] P.O. Box 231, New Aiyansh, BC V0J 1A0

Cat. No. Fs 97-4/2373E ISSN 0706-6473

Correct citation for this publication:

Nass, Bryan L. 1996. Escapement enumeration studies of adult coho salmon at Zolzap Creek, B.C., 1993. Can. Manuscr. Rep. Fish. Aquat. Sci. 2373: viii. + 35 p.

TABLE OF CONTENTS

TABLE OF CONTENTS - Cont'd

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Nass, B. L. 1996. Escapement enumeration studies of adult coho salmon at Zolzap Creek, B.C., 1993. Can. Manuscr. Rep. Fish. Aquat. Sci. 2373: viii + 35 p.

Adult coho escapement to Zolzap Creek, British Columbia, was monitored using an in-stream fence and upstream mark-recapture surveys. The counting fence was operational between 25 August and 19 November except for the period 2 to 11 November in which flooding prohibited operations. Mark-recapture surveys were conducted on 18, 24, and 26 November. Estimated adult coho escapement was 1,048 using the adjusted Petersen model. Fifty-one jacks were counted at the fence, however, an escapement estimate for jacks could not be derived. Adipose-clip rates at return were 24.4% and 27.5% for adults and jacks, respectively. Age and length characteristics of adult males, females, and jacks are described.

Canadian and U.S. commercial harvests were examined using coded-wire tag recovery data obtained from the Mark-Recovery Program. Total commercial exploitation rate on Zolzap Creek coho was an estimated 63.0% (15.5% Canadian, 47.5% U.S.). Of the total commercial catch of Zolzap Creek coho, Canadian catch accounted for an estimated 24.6% and the U.S. catch accounted for an estimated 75.4%. Harvests occurred over a wide area ranging from Canadian Statistical Area 6 (northwest of Bella Bella, B.C.) to the Northern Outside Statistical Area in Alaska (northwest of Juneau, AK). Canadian harvests were largest in Statistical Area 3 for both the net and troll fisheries. U.S. harvests were confined entirely to Alaska with largest in the Southern Inside Statistical Area for the net fishery and the Central Outside Statistical Area for the troll fishery. Smolt-to-adult survival was estimated to be 2.1%. Smolt-to-spawner survival was estimated to be 0.75%.

RÉSUMÉ

Nass, B. L. 1996. Escapement enumeration studies of adult coho salmon at Zolzap Creek, B.C., 1993. Can. Manuscr. Rep. Fish. Aquat. Sci. 2373: viii + 35 p.

Cette étude avait pour objet d'évaluer le taux d'échappement des saumons cohos adultes dans la rivière Zolzap, en Colombie-Britannique, au moyen d'une barrière de comptage sous eau et d'une campagne de récupération des spécimens marqués, en amont. La barrière de comptage a été opérationnelle entre le 25 août et le 19 novembre, sauf pendant une période de crue qui a empêché la poursuite des opérations, entre le 2 et le 11 novembre. Les opérations de récupération des spécimens marqués se sont déroulées les 18, 24 et 26 novembre. Le taux d'échappement des cohos adultes, établi selon le modèle Petersen modifié, a été estimé à 1 048 individus. Un effectif de cinquante-et-un mâles précoces (*jacks*) a été recensé à la barrière, mais il n'a pas été possible d'établir le taux d'échappement correspondant. Le taux de récupération des spécimens dépourvus de nageoire adipeuse était de 24,4 % pour les cohos adultes et de 27,5 % pour les jeunes mâles précoces. Le rapport d'étude donne les distributions d'âge et de taille pour les adultes mâles et femelles et pour les jeunes mâles précoces.

Les captures commerciales des pêcheurs canadiens et américains ont été étudiées au moyen des données recueillies lors de la campagne de récupération des spécimens étiquetés. Le taux global d'exploitation commerciale des stocks de saumon coho de la rivière Zolzap a été estimé à 63,0 % (15,5 % pour la pêche canadienne et 47,5 % pour la pêche américaine). Du taux global des captures commerciales de saumons cohos de la rivière Zolzap, les prises canadiennes comptaient pour environ 24,6 % et les prises américaines pour environ 75,4 %. Ces pêches couvraient un vaste territoire, allant de la zone statistique canadienne 6 (au nord-ouest de Bella Bella, en Colombie-Britannique) jusqu'à la zone statistique extérieure nord, en Alaska (au nord-ouest de Juneau). Les pêches canadiennes les plus importantes ont été enregistrées dans la zone statistique 3, chalutiers et ligneurs confondus. Les pêches américaines étaient entièrement confinées à l'Alaska, les plus importantes étant enregistrées dans la zone statistique intérieure sud pour ce qui est des chalutiers, et dans la zone extérieure centrale pour ce qui est des ligneurs. Le taux de survie des cohortes de smolts jusqu'au stade adulte a été estimé à 2,1 %, alors que leur taux de survie jusqu'au stade de reproduction a été estimé à 0,75 %.

INTRODUCTION

As part of an agreement between the Nisga'a Tribal Council and the Canadian Government, an Interim Measures Program (IMP) was established in 1992 for fisheries research in the Nisga'a Land Claim Area, British Columbia. One component of this large research initiative focused on the assessment of adult coho (*Oncorhynchus kisutch*) escapement in Zolzap Creek, a tributary to the Nass River (Nass 1996b). In 1993, adult coho escapement studies at Zolzap Creek continued with funding from the Province of British Columbia under the BC21 program.

In the spring of 1992 and 1993, coho smolts leaving Zolzap Creek were enumerated and coded wire tagged (Nass 1996a; Nass and English 1994). The 1993 escapement of adult and jack returns were monitored for adipose clips which would indicate the presence of a coded-wire tag.

The objectives of this research were to:

1. Estimate the escapement of coho to Zolzap Creek;

2. Document the timing, size, sex, maturation, and age distribution of the escapement; and

3. Monitor the escapement for marked (CWT) adult and jack coho, and determine oceanic exploitation and survival rates.

Achievement of these objectives involved the construction and operation of an aluminum panel fence located approximately 0.5 km upstream of the mouth of Zolzap Creek and conducting mark-recapture surveys at known spawning locations. Further details are presented in the methods section.

STUDY STREAM

Zolzap Creek is a tributary to the Nass River, located in northwestern British Columbia, Canada (Fig. 1 and 2). Zolzap Creek flows for 6 km in a northwesterly direction between Nisga'a Memorial Park (lava beds) and the Kitimat range, to its confluence with the Nass River, 5 km downstream of Gitwinksihlkw. The lower 0.5 km of the creek regularly becomes inundated when water levels on the Nass River are high. Zolzap Creek supports many species of salmonids including coho, pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), steelhead (*O. mykiss*), cutthroat (*O. clarki*), and Dolly Varden (*Salvelinus malma*). Mean adult escapement estimates of coho, pink, and chum for the period 1980-1988 are 581, 483, 209, respectively (Jantz et al. 1989). Coho escapement was estimated to be 1,831 in 1992 (Nass 1996b).

METHODS

PHYSICAL OBSERVATIONS

Crews monitored water temperatures, water levels, and weather conditions daily. An electronic data logger was used to measure maximum and minimum water level and temperature over 24 h. The logger's probe was located within 50 m of the fence. Secondary measures of water level and temperature were monitored using staff gauges and a max-min thermometer, respectively. Gauges were located within 50 m of the fence.

POPULATION ESTIMATES

Fence Enumerations

An aluminum conduit fence anchored to a crib type sill was constructed at Zolzap Creek. All salmonids caught at the fence were counted. Coho were classified by sex as males, females, or jacks. Sex was distinguished on the basis of length and body morphology. Crews were instructed to use 35 cm to distinguish male coho from jacks (all male coho less than 35 cm were classified as jacks). Coded-wire tag analysis for coho at Black Creek and French Creek, Vancouver Island, suggested 35 cm to be the most appropriate length to differentiate between adult and jack coho (Bocking et al. 1992; Nass et al. 1993b). Maturity of each coho was also noted according to the following scale: 1 = silver bright, 2 = secondary spawning characteristics beginning to form, 3 = secondary characteristics well formed, 4 = ripe (full bellies), 5 = spawning, 6 = spawned out, and 7 = carcass. Each coho was tagged on the operculum with a uniquely numbered Ketchum kurl-lock tag and sampled for length. During handling, fish were examined for fin clips or tags that would be associated with coded-wire tagging or mark-recapture studies taking place on the Nass River. All coho were released upstream of the fence.

Mark-recapture Estimates

Coho were recovered in upstream surveys by netting. Survey sites are illustrated in Figure 2. A mark-recapture estimate of the spawning population was generated using the adjusted Petersen model (Ricker 1975). Potential biases in the estimate using this model are well documented (Cousens et al. 1982; Labelle 1990a) and a detailed discussion related to Zolzap Creek operations is presented in Nass (1996b).

AGE, LENGTH, AND SEX COMPOSITION

All live coho captured at the fence were measured for postorbital-hypural length and examined for fin clips, sex, and maturity. Sex ratios were calculated from total fence captures. Mean lengths were calculated for adult males, adult females, and jacks. Crews attempted to sample at least 25 coho a day for scales (10 scales per fish). The actual number of samples was more or less dependent on migrations and logistics. Scale samples were

interpreted by the Canada Department of Fisheries and Oceans Scale Lab, Vancouver, B.C. Secondary quality control checks were performed to ensure reliability of the age designations. Scale ages are reported in Gilbert-Rich notation where freshwater age 2 coho (having survived two winters from egg deposition) have a single freshwater annulus.

Stream life for recaptured coho was determined using available data. Stream life was defined as the number of days a fish remains alive upstream of the counting fence. This is determined as the date recovered minus the date tagged (known from tag number). An estimate of the number of days dead is recorded for carcass recoveries.

CODED-WIRE TAG RECOVERIES

Coho smolts at Zolzap Creek were coded-wire tagged (CWT) in the spring of 1992 and 1993 during their migration (Nass 1996a; Nass and English 1994). Coded-wire tagged smolts were adipose fin clipped (AFC) prior to release for future identification. In this paper, the contribution and survival of these fish to the 1993 escapement, the Canadian commercial and sport fisheries, and United States (U.S.) commercial fishery is examined.

Escapement

Crews examined all coho captured at the fence for the presence or absence of the adipose fin. The contribution and survival of AFC coho to the escapement was determined using methods presented in Bocking et al. (1992). The equations were modified for use with this data set (sex and tag code stratification eliminated) and are presented below. A detailed discussion of potential biases associated with this method is presented in Bocking (1991).

First, the estimated number of adipose clips (*EAD*) in the escapement was calculated by:

$$EAD = \frac{OAD * P}{C} \quad (1)$$

where *OAD* is the observed number of adipose clips, *C* is the number of fish examined, and *P* is the Petersen population estimate.

Next, the estimated contribution (*EC*) of the release group (in this case, the total 1992 spring migration) to the escapement was calculated by expanding the estimated number of adipose clips for the proportion of unclipped smolts:

$$EC = EAD * \frac{(RC + RUC)}{RC} \quad (2)$$

where *RC* is the number of smolts released with AFC's and *RUC* is the number of smolts released without adipose fin clips. Note that if a substantial number of unclipped smolts associated with the release group migrated out undetected, the actual contribution to escapement would be underestimated. This method assumes that the survival of marked fish is equal that of unmarked fish.

Finally, the smolt to spawner survival rate (*SSS* - includes natural and harvest mortality) was calculated as:

$$SSS = \frac{EAD}{RC} \quad (3)$$

Note that if a substantial number of AFC fish strayed to other systems, or AFC fish in the escapement were not recorded (misidentified as an unclipped fish), the actual smolt to spawner survival rate would be underestimated. The extent of straying or observer error was not conducted in this study.

Commercial and Sport Harvests

Commercial and sport catch of CWT fish are monitored by the Department of Fisheries and Oceans and various U.S. agencies and compiled in the Mark Recovery Program (Kuhn et al. 1988). Data on CWT releases and recaptures are used to estimate the number of fish from a particular stock that have been harvested in the commercial and sport fishery, as well as determining the spacial and temporal distribution of harvests. A description of the mark-recovery program and the catch estimation calculations are presented in Kuhn et al. (1988), however, the relevant components are presented below.

Coded-wire tags that are caught in a fishery and subsequently decoded are termed "observed" tags. The MRP program reports these as adjusted observed numbers to account for non-tag recoveries such as "No pin", Lost pin" and "No Data". The observed CWT catch represents only a proportion of all the tags caught in the fishery because sampling is not complete. Therefore, an estimate of the total CWT catch (*EST*) is calculated by:

$$EST = OBS * \frac{CAT}{SAM} \quad (4)$$

where *OBS* is the adjusted number of tags decoded, *CAT* is the total catch for a specific species, fishing area, and gear type, and *SAM* is the number of fish sampled from the catch for the presence of a CWT. The term *CAT/SAM* is commonly referred to as the catch to sample ratio. Catch of CWT's are stratified according to individual stock specific tag codes. However, in this analysis, the release and recovery data for individual tag codes (presented as totals in the tables) is combined to represent the Zolzap Creek coho stock.

Finally, the "expanded" catch (*EXP1*) of the fishery is calculated by:

$$EXP1 = EST * \frac{REL}{TAG} \quad (5)$$

where *REL* is total number of fish released and *TAG* is the total number of fish released with tags (corrected for tag loss). The term *REL/TAG* is commonly referred to as the mark rate at release. Therefore, the expanded catch includes unmarked fish captured in the fishery that belong to the same group of fish that were tagged. For this calculation to be accurate, it requires a known number of unclipped releases. Similar to the calculation of contribution to escapement of adipose clips as described above, a substantial number of unclipped smolts migrating out undetected will cause the actual expanded catch to be underestimated.

Expanded catch (*EXP2*) was also calculated using the AFC rate at return (escapement method) as:

$$EXP2 = EST * \frac{TOT}{ADP} \quad (6)$$

where *TOT* is the number of fish examined in the escapement for adipose clips and *ADP* is the number of coho with adipose clips. This ratio represents the "true" proportion of marked fish in the population if it is assumed: 1) that coho observed with an AFC possess a coded-wire tag; and 2) that the observed escapement were Zolzap origin (i.e., no strays from other systems). A substantial difference between the AFC rate at return and the mark or AFC rate at release may indicate that there are potential sampling problems during spring or fall fence operations. Note that the mark rate at release and the AFC rate at return are directly comparable only if the latter represents actual CWT returns.

Commercial exploitation rate (*ER*) on coded-wire tagged coho from Zolzap Creek was calculated as:

$$ER\% = \frac{EST}{(EST + EAD)} * 100 \quad (7)$$

The estimated CWT catch (*EST*) can be stratified by fishery or summed for a total exploitation rate.

Total Return

An estimate of the total adult return (*RTN*) was calculated as:

$$RTN1 = EXP1 + EC \quad (8)$$

and

$$RTN2 = EXP2 + ESC \quad (9)$$

where *RTN*1 is based on the adipose-clip rate at release, *RTN*2 is based on the adipose-clip rate at return, and *ESC* is the estimated escapement.

Smolt to adult survival rate (*SAS*) (i.e., recruitment to the fishery) was calculated as:

$$SAS\% = \frac{(EST + EAD)}{RC} * 100 \quad (10)$$

Geographic Distribution of Harvest

Coded-wire tags in the commercial catch are recorded by Canadian and U.S. fishery Statistical Areas. To estimate number of recoveries for each Canadian area, the observed CWT catch in each area was expanded by the mean catch-sampling ratio observed in the Catch Region (e.g., Northern Troll = Stat Areas 1 to 5, inclusive). Similarly, U.S. troll catch was expanded using the catch sampling ratio by quadrant (e.g., northwest) and the net catch by district (e.g., 113; see Shaul 1994).

RESULTS

PHYSICAL OBSERVATIONS

The water level at Zolzap Creek was steady from late August to late October until heavy rainfall caused intermittent flooding (Fig. 3). Zolzap Creek rose approximately 1.7 m from its minimum level. Water temperatures ranged from a maximum of 11.7° C in September to a minimum of 5.0° C in November (Fig. 3).

POPULATION ESTIMATES

Fence Enumerations

The fence was operated from 25 August to 19 November. The fence was not operational between 2 November and 11 November due to flooding. An unknown number of coho moved past the fence during this period. Hence, there was not a complete count for adult or jack coho.

A total of 794 adults and 51 jacks were counted at the fence (Table 1). Of these, 775 adults and 49 jacks were operculum tagged and released upstream. Maximum daily migration past the fence reached 322 adults and 9 jacks on 29 October (Table A1, Fig. 4).

For non-coho species captured at the fence, pink salmon had the greatest abundance (149), followed by chum (111) and sockeye (11). Cutthroat trout (27) and Dolly Varden (21) were also captured at the fence. Pink and chum salmon were caught in their greatest numbers in early September and were observed passing the fence site prior to complete installation. Trout were caught primarily in late October. An unknown number of non-coho fish migrated upstream after the fence was removed.

Mark-recapture Estimates

Crews examined a total of 76 adult coho in upstream mark-recapture surveys conducted at four different sites on the creek (Table 2). Of these, 56 were tagged which resulted in an estimate of 1,048 adults escaping to Zolzap Creek in 1993 (Table 3). No jack coho were recaptured during the surveys and, therefore, an estimate of jack escapement could not be calculated.

AGE, LENGTH, AND SEX COMPOSITION

A total of 134 coho were sampled for scales, of which 111 were aged (Table 4). Unaged samples included 23 marine regenerates. Adult males and females had similar age compositions which averaged 60.0% and 54.8% freshwater age 2, and 40.0% and 45.2% freshwater age 3, respectively. There was a single age 4 adult coho recorded. Jacks had a

substantially higher proportion of age 2 fish (80.0%) than age 3 (20.0%). All aged scales were recorded as marine age 1 (having 1 marine annulus).

Mean lengths of adult males, females and jacks were 48.9 cm (n=474, SD=8.4), 53.1 cm (n=302, SD=5.9), and 31.5 cm (n=51, SD=2.4), respectively. Female coho were significantly larger than adult male coho (t-test, $p < 0.001$).

Adult male coho were widely distributed over the range of 35 to 70 cm with the highest representation in the 37 and 55 cm size classes (Fig. 5). Jack coho were most abundant in the 34 cm size class. Female coho were distributed around 51 cm with a range of 35 to 69 cm.

Adult males captured at the fence (481) were significantly more abundant than females (313) (χ^2, $p < 0.001$). Jack coho (51) increased the ratio of male to female spawners from 1.5 to 1.7.

Recovery of carcasses for determination of stream life was hampered by water conditions; however, stream life values of 11 and 21 d were calculated using two recoveries. Supplemental information from mark-recapture data indicated coho surviving upstream for at least 31 d.

CODED-WIRE TAG RECOVERIES

Escapement

Crews observed a total of 191 adipose-clipped adult coho (784 examined) and 14 adipose-clipped jack coho (51 examined). This results in an AFC rate at recovery of 24.4% and 27.5% for adults and jacks, respectively (Table 5). An estimated 255 adipose clipped adult coho returned to Zolzap Creek in 1993. Adipose-clip escapement for jacks was not calculated due to lack of data. Smolt to spawner survival (includes natural and harvest mortality) for adult coho was estimated at 0.75% (Table 6). The presence or absence of a coded-wire tag in adipose-fin clipped coho was not investigated.

Commercial and Sport Harvests

Total observed Zolzap Creek coho CWT recoveries were 31 (Table 7) and 113 (Table 8) for Canadian and U.S. (Alaska) fisheries, respectively. No Canadian sport recoveries were recorded. All CWT recoveries were from the 1992 release year. Canadian catch to sample ratios were higher than those reported for the U.S. fishery: northern Canadian troll and net were 5.0 and 2.7, respectively; while U.S. troll and net were 3.0 and 2.6, respectively. Estimated Zolzap Creek CWT coho catches were 107 and 328 for Canadian and U.S. fisheries, respectively. Using the CWT mark ratio at release (MRP method), expanded Canadian and U.S. catches were 131 and 402, respectively, for a total of 533

(Table 9). Using the adipose-clip ratio at recovery (escapement method), expanded Canadian and U.S. catches were 439 and 1,345, respectively, for a total of 1,784 (Table 9).

Total commercial exploitation rate (Canadian and U.S.) on Zolzap Creek coho was 63.0%. Total Canadian exploitation rate was 15.5% (7.2% troll, 8.3% net) and total U.S. exploitation rate was 47.5% (36.3% troll, 11.2% net). Of the total commercial catch of Zolzap Creek coho, Canadian fisheries accounted for 24.6% and the U.S. accounted for 75.4%. U.S. troll and net fisheries accounted for 76.5% and 23.5% of the total U.S. catch, respectively. Canadian troll and net fisheries accounted for 46.7% and 53.3% of the total Canadian catch, respectively.

Total Return

Estimated total adult return for Zolzap Creek coho was 838 and 2,832 using the MRP and escapement methods, respectively (Table 9). Smolt to adult survival (recruitment to fishery) was 2.1%.

Geographic Distribution of Harvest

Commercial harvest of Zolzap Creek coho occurred over a wide area ranging from Canadian Statistical Area 6 to the U.S. Northern Outside Statistical Area in Alaska (Fig. 6). Canadian harvests were largest in Statistical Area 3 for both the net (11.3%) and troll fisheries (6.9%; Table 10). U.S. harvests were largest in the Southern Inside Statistical Area for the net fishery (10.3%) and the Central Outside Statistical Area for the troll fishery (18.9%; Table 10).

DISCUSSION

POPULATION ESTIMATES

Adult coho enumerated at the fence (794) accounted for 75.8% of the Petersen population estimate (1,048). Therefore, approximately 254 adults (24.2%) entered Zolzap Creek during the period in which the fence was not operational or after the fence was removed. In 1992, adult escapement was estimated at 1,561 (Nass 1996b).

Counts of other salmonids at the fence produced two noteworthy observations. First, total chum counted at the fence was up to 111 from 30 in 1992 and steelhead were down to 0 from 5 in 1992 (Nass 1996b). Other species had similar numbers between years. Population estimates were not calculated for any non-coho species.

AGE, LENGTH, AND SEX COMPOSITION

Potential sampling bias in age composition of returning adults in 1992 prompted the use of modified sampling procedures in 1993. The number of scale samples was increased from 2 to 10 per fish. The rate of non-ageable fish due to scale regeneracy decreased from 46% in 1992 to 17% in 1993. The increase in ageable scales corresponded with an increase in the proportion of freshwater age 3 fish represented in the samples. These results support previous findings (Jeff Till, DFO Scale Lab, Vancouver, B.C., pers. comm.) which have found that the regeneracy rate of scales is approximately 2 times higher in freshwater age 3 coho compared to age 2. The freshwater age distribution of adult coho returning to Zolzap Creek in 1993 (58.3% age 2 and 41.7% age 3) was similar to the age distribution observed in the migrating smolt population in 1992 (54.3% age 2 and 45.7% age 3; Nass 1996a).

The total number of successfully aged coho was 111. This sample included 15 coho designated as jacks (based on a length <35 cm POH). Lengths of the sampled jacks ranged between 27 and 34 cm (mean 30.9 cm). All aged scales, including the samples designated as jacks, were recorded as marine age 1 (having 1 marine annulus) which implies a winter of marine residence. The same was true for all samples in 1992 of which 9 were jacks (Nass 1996b). The scale age results indicate that the coho designated as jacks according to their length were actually adults and is based on the assumption that jacks do not obtain a marine annulus (i.e., smolt and return in the same year). This information contrasts with data for the Lachmach River which shows that coho less than 35 cm were jacks as determined from scale, fin, and otolith analysis (Lane et al. 1994b). The same relationship was found for coho at Black Creek and French Creek, Vancouver Island (Bocking et al. 1992; Nass et al. 1993b). The length-frequency distribution of returning coho to the Lachmach also shows a distinct bimodal pattern that illustrates the difference in length between adults and jacks (Lane et al. 1994b). The length-frequency distribution of returning adults to Zolzap Creek (Fig. 5) does not show a distinct bimodal pattern can be interpreted as supporting the scale age analysis. A similar pattern was observed in the 1992 length-frequency distribution of escapement to Zolzap Creek (Nass 1996a). Also in 1992, there were no adipose clips observed in the escapement (n=691 adults, n=80 jacks) and indicates there was no contribution from 1992 coded-wire tagged coho smolts (Nass 1996a). Therefore, observations from 1992 and 1993 suggest that there is little to no contribution of jacks to the Zolzap Creek escapement.

One hypothesis regarding the observed age-length structure of the escapement to Zolzap Creek is that small returning coho may be the result of smolts that have migrated to the ocean late in the summer or fall. The timing of arrival in the ocean may have allowed for a marine annulus to be formed, however, the growth of these particular fish may be less than others because they have only reared in the ocean for one summer. This hypothesis is also supported by the observed AFC rates at Zolzap Creek which were similar between adults and jacks and may indicate that they are of the same migration year. A simpler hypothesis is that the small returning adults were relatively small smolts that migrated during the regular migration period. In contrast, it is possible that the scale age results are

unreliable for distinguishing adult and jack coho and should be verified with other hard structure analyses.

The condition of whether or not small returning coho at Zolzap Creek are adults or jacks has obvious implications on escapement estimates, age and length distributions, and estimates of exploitation rate and total return. However, given the small sample size of jacks aged successfully and strong evidence of jacking at other systems, the stratification of jacks and adult males according to length was retained for this analysis. Increased scale sampling and analysis of coded-wire tag recoveries of small coho in future studies may provide new information regarding these results.

CODED-WIRE TAG RECOVERIES

Escapement

Escapement to Zolzap Creek in 1993 was the first year of expected adult returns with coded-wire tags. In 1992, 33,923 CWT and adipose-fin clipped smolts and 6,678 unclipped smolts were released (Nass 1996a) and resulted in a AFC rate of approximately 84%. However, smolt trapping operations were not operational due to flooding for approximately one-third of the usual trapping season; thus, a complete migration estimate was not possible. Based on the pattern of migration, Nass (1996a) estimated that an additional 12,350 smolts migrated undetected for a total migration of 53,008. Therefore, AFC releases likely represented approximately 64% of the estimated migration and was also the expected AFC rate in the 1993 escapement (Nass 1996a). The observed AFC rate at return in 1993 was 24.4%. Based on the escapement of 1,048 adult coho, the estimated escapement of adipose clips was 255, while the expected number was 671.

Discrepancies between AFC rates at release and return have been documented at other systems. Over a 3-yr period (1989-1991), release clip rates at Black Creek were approximately 99% while return clip rates averaged 87% (Bocking et al. 1991; Nass et al. 1993a; Nass et al. 1993b; Nelson et al. 1994a; Nelson et al. 1994b). At Lachmach River, release clip rates of approximately 93% and 97% for 1989 and 1990 produced return rates of 57% and 71%, respectively (Davies 1991a; Davies 1991b; Lane et al. 1994a; Lane et al. 1994b). Some of the factors which could contribute to such a dramatic difference between AFC rates at release and return at Zolzap Creek are discussed below:

1) Total Unclipped Migration of Smolts Underestimated:

Smolt trapping operations in 1992 did not completely cover the normal migration period and likely missed a substantial portion of the run. Underestimating the total migration of smolts would result in an overestimate of the mark rate or AFC rate at release (and the expected rate at recovery). Assuming equal survival of CWT and untagged coho, the number of additional unclipped smolts leaving the system would have to have been approximately 98,200 (a total migration of 138,700) to result in the mark ratio observed in

the escapement. Although this is a substantial number of juveniles to "miss" in the migration, studies at Tseax River (another tributary to the Nass) have shown that downstream migration of juvenile coho occurs over the entire year and that migration peaks can occur during fall freshets (Alexander and Bocking, 1994). These observations are supported by Labelle (1990a) who concluded it was likely that, for several Vancouver Island streams, a substantial portion of the smolt population was leaving the system outside the main migration pulse observed in the spring. Downstream migration outside of the usual spring migration period is supported by other studies as summarized by Sandercock (1991).

In addition, scale age analysis for Zolzap Creek coho smolts has shown a substantial overlap in the length frequency distribution of freshwater age 2 and 3 fish; possibly an indication of habitat limitation and displacement behaviours (discussed in Nass and English 1994, Nass 1996a). One hypothesis is that displaced coho may reside in downstream habitats such as Zolzap Slough (Nass River side channel downstream of Zolzap Creek) where they would be undetected during spring enumeration studies. It is possible though that these fish may return as adults to Zolzap Creek.

2) *Differential Mortality of Tagged Smolts vs. Untagged Smolts:*

It is possible that juveniles captured and coded-wire tagged during the migration had a higher mortality rate than those released untagged. A higher mortality rate would result in a lower AFC rate at return. Blankenship and Hanratty (1990) found mortality to be approximately 16% higher for planted coho smolts captured and tagged at an in-stream fence, compared to planted smolts released below the fence. The estimated AFC rate at return for Zolzap Creek coho would be 53.8% at a 16% differential mortality rate. Based on the number of smolts released, tagged, and untagged in 1992, mortality of tagged coho would have had to been approximately 5.7 times greater than for untagged coho (or 93%) in order to obtain the AFC rate observed in the escapement. This level of differential mortality is unrealistic given observations Blankenship and Hanratty (1990), and our observations of low post-tagging mortality (< 1%) for juveniles coded-wire tagged and held for 24, 48, and 72 h tag retention tests at Zolzap Creek. Similarly, in a related study, low post-tagging mortality (2.9%) was observed over a 8-mo period for CWT pen reared juvenile coho at the Tseax River (Alexander and Bocking 1994).

3) *High Stray Rate of CWT Adults:*

Escapement of salmon to non-natal streams for spawning (straying) has been documented for several species of salmon and is considered a natural part of the salmon life history. Straying of Zolzap origin coho from the creek or straying of coho to the creek (e.g., juveniles that originate from spawners in Zolzap Slough, but contribute to the adult escapement at Zolzap Creek) could contribute to the lower than expected AFC rate in the 1993 Zolzap escapement. Labelle (1992) reported that south coastal coho stocks strayed at rates between 0% and 54% of the adult stock, but that the mean straying rate was approximately 1%. At an atypical straying rate of 50%, 128 CWT coho would stray from

Zolzap Creek. At this rate, including these fish in the escapement would only raise the observed AFC rate to 33% (expected 64%). However, the above straying analysis is based on data for coastal systems and it may not apply to Zolzap Creek or other tributaries to big river systems where spawning and rearing may take place in different places. For example, it is possible that juveniles which originate from spawners in Zolzap Slough, rear in Zolzap Creek. Therefore, these fish could be marked during the smolt migration as part of the population, only to return to spawn in Zolzap Slough. The result would be fewer marks observed in the creek.

4) Misidentification or Regeneration of Adipose Clips in Escapement:

Incidental observer error in reporting adipose clips or having adipose-clip regeneration would result in an underestimate of the true AFC rate at recovery. This condition is highly unlikely, at least to the extent required to obtain the observed difference in release and recapture AFC rates. First, observer error is unlikely since crews had relatively few fish to process and, secondly, crews observed only two "deformed" adipose fins in the 1993 escapement which would indicate regenerates or poor fin clipping at release.

In summary, it is likely that all of the above mentioned factors have some degree of influence on the observed AFC rate at return; however, only additional unclipped releases and substantial straying (to or from the creek) can account for the majority of the discrepancy with the AFC rate at release.

Commercial and Sport Harvests

The estimated number of adipose clips in the escapement (EAD) is used in the calculation of the estimates of smolt to adult survival rate and exploitation rate. Substituting the estimated escapement of AFC coho for the actual escapement of CWT coho makes the assumption that AFC coho in the escapement possess CWT's. There was no confirmation of CWT's for the 1993 escapement. If this assumption is violated, the estimates of total return, survival to adult, and exploitation rate would be affected accordingly. For example, if the escapement of AFC's overestimate the number of escaping CWT coho (e.g., due to tag loss), the survival rate would be overestimated and the exploitation rate underestimated. However, shedding of CWT's is typically low after immediate losses at tagging (determined by tag retention tests). For example, CWT retention for Lachmach River smolts was 95% (n=46) and 100% (n=19) in two separate adult recovery years (Lane et al. 1994a; Lane et al. 1994b). Similarly, tag retention over a 7-mo period was 94.6% for pen reared juvenile coho at the Tseax River, B.C. (Alexander and Bocking 1994). In contrast, if the escapement of AFC coho is underestimated (clips missed during escapement examination or AFC fish straying to other systems), survival rate would be underestimated and the exploitation rate overestimated. In either case, it would take a substantial number of unaccounted CWT fish to affect the results of the analysis.

At this time, there is very little published literature on the exploitation and survival rates of northern coho stocks in B.C. Kadowaki (1988) examined early run Skeena River coho stocks for which exploitation rates ranged from 56-72% in the mid-1980's. These estimates were not based on CWT recoveries and are believed to be fairly unreliable (Irvine et. al. 1992). In contrast to the situation in B.C., comprehensive information exists for several southeast Alaskan stocks, including Hugh Smith Lake (Southern Inside Statistical Area, see Fig. 6), which has been monitored since 1982 (Shaul 1994). Average exploitation rates on Hugh Smith coho for the period 1982-1990 were 9.4% Canadian and 56.8% U.S. (66.2% total; Shaul 1994). Total exploitation rate ranged between 56.8% and 82.1% for the same period. Preliminary data for the 1993 return suggests exploitation rates of 5.6% Canadian and 75.0% U.S. (80.6% total; Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.). This is substantially higher compared to exploitation rates of 15.5% Canadian and 47.5% U.S. (63.0% total) on Zolzap Creek coho for 1993. Zolzap and Hugh Smith coho were harvested in many of the same Statistical Areas; however, total catch or exploitation rate distributions were not compared by Statistical Area.

Total Return

For the period 1982-1989, smolt-to-adult survival for Hugh Smith coho averaged 10.7% (range 4.2% - 19.1%; Shaul 1994). Preliminary CWT data for the 1993 return of Hugh Smith coho suggest a survival rate of 18.1% (Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.). At this time, it is not clear why Zolzap Creek coho, which at least partially overlap with Hugh Smith coho in oceanic distribution, had a comparatively low survival rate (2.1%). Variability in survival between geographically proximate stocks has been shown by Labelle (1990b).

ACKNOWLEDGEMENTS

The cooperation of many people was essential in meeting the objectives of this study. Special thanks go to Leonard Squires for monitoring operations as crew supervisor. Paul Gosselin, Vincent Johnson, Edward McKay, Archie Nyce, and Peter "Normy" Squires constructed and operated the fence. Bob Bocking and Karl English provided technical support and reviewed the manuscript. Doug Herriot of the Department of Fisheries and Oceans provided the CWT catch data from the Mark Recovery Program. Robin Tamasi provided GIS support.

Funding for this project was provided by the province of British Columbia under the BC21 program.

REFERENCES

Alexander, R. and R.C. Bocking. 1994. Results from Tseax River enhancement program for coho salmon, 1992 and 1993, and the monitoring of downstream migrant salmonids, 1993. Unpublished Report NF94-05 prepared by LGL Limited for the Nisga'a Tribal Council and Fisheries and Oceans, Canada.

Blankenship, H.L. and P.R. Hanratty. 1990. Effects on survival of trapping and coded wire tagging coho salmon smolts. Am. Fish. Soc. Symp. 7:259-261.

Bocking, R.C. 1991. Stamp falls fishway counts, adipose clip/CWT recovery and biological sampling of chinook salmon escapements in Stamp River and Robertson Creek Hatchery, 1990. Can. Tech. Rep. Fish. Aquat. Sci. 1815: x + 92p.

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

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

Cousens, N., G. Thomas, C. Swann, and M. Healey. 1982. A review of salmon escapement estimation techniques. Can. Tech. Rep. Fish. Aquat. Sci. 1108: 122p.

Davies, D. 1991a. Summary of the 1989 coho salmon smolt trapping operations on the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 831: 37p.

Davies, D. 1991b. Summary of the 1990 coho salmon smolt trapping operations on the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 832: 53p.

Irvine, J.R., R.C. Bocking, K.K. English, and M. Labelle. 1992. Estimating coho salmon (*Oncorhynchus kisutch*) spawning escapements by conducting visual surveys in areas selected using stratified random and stratified index sampling designs. Can. J. Fish. Aquat. Sci. 49: 1972-1981.

Jantz, L., D. Burnip and S. Hildebrandt. 1989. Salmon escapement and timing data for statistical area 3 of the north coast of B.C. Canada Dept. of Fisheries and Oceans, Prince Rupert, B.C.

Kadowaki, R.K. 1988. Stock assessment of early run Skeena River coho salmon and recommendations for management. Can. Tech. Rep. Fish. Aqua. Sci. 1638: 29 p.

Kuhn, B.R., L. Lapi, and J.M. Hamer. 1988. An introduction to the Canadian database on marked Pacific salmonids. Can. Tech. Rep. Fish. Aquat. Sci. 1649: viii + 56p.

Labelle, M. 1990a. A comparative study of the demographic traits and exploitation patterns of coho salmon stocks from S.E. Vancouver Island, B.C. PhD Thesis. University of British Columbia. 264 p.

Labelle, M. 1990b. A comparative study of coho salmon populations of S.E. Vancouver Island, British Columbia: juvenile outmigration, coded-wire tagging and recovery, escapement enumeration, and stock composition at Black Creek, Trent River and French Creek, 1984-88. Can. Tech. Rep. Fish. Aquat. Sci. 1722: 148 p.

Labelle, M. 1992. Straying patterns of coho salmon (*Oncorhynchus kisutch*) stocks from Southeast Vancouver Island, British Columbia. Can. J. Fish. Aquatic. Sci. 49: 1843-1855.

Lane, J., J. Taylor, and B. Finnegan. 1994a. Summary of adult coho escapement to the Lachmach River, B.C., 1990. Can. Data Rep. Fish. Aquat. Sci. 932: 69 p.

Lane, J., J. Taylor, and B. Finnegan. 1994b. 1991 adult coho escapement and summary of the 1988 - 1990 escapement years to the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 938: 53 p.

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

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

Nass, B.L. 1996a. Enumeration and coded-wire tagging of coho salmon smolts at Zolzap creek, and enumeration of coho salmon smolts at Seaskinnish and Ginlulak creeks, 1992. Can. Man. Rep. Fish. Aquat. Sci. 2376: viii + 44 p.

Nass, B.L. 1996b. Escapement enumeration studies of adult coho salmon at Zolzap Creek, 1992. Can. Man. Rep. Fish. Aquat. Sci. 2374: viii + 30 p.

Nass, B.L. and K.K. English. 1994. Enumeration and coded-wire tagging of coho salmon smolts at Zolzap Creek, 1993. Report NF 93-01 prepared by LGL Limited, Sidney, BC, for the Nisga'a Tribal Council, New Aiyansh, BC.

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

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

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Can. 191. 382 p.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). *In* Pacific Salmon. Edited by Groot, C. and L. Margolis. UBC Press. Vancouver.

Shaul, L.D. 1994. A summary of 1982-1991 harvests, escapements, migratory patterns, and marine survival rates of coho salmon stocks in southeast Alaska. Alaska Fish. Res. Bull. 1 (1): 10-34.

TABLES

Table 1. Summary of Zolzap Creek fence enumerations of adult and jack coho, 1993.

Item	Adults	Jacks	Total
Number coho captured at fence	794	51	845
Number coho operculum tagged	775	49	824
Number of coho released untagged	19	2	25

Table 2. Upstream mark-recapture effort and catch of adult and jack coho, Zolzap Creek, 1993.

		Adults					Jacks				
		tagged		untagged			tagged		untagged		
Date	Location	No.	%	No.	%	total	No.	%	No.	%	total
18 Nov	2	0	0	0	0	0	0	0	0	0	0
	3	1	33	2	67	3	0	0	0	0	0
	6	0	0	1	100	1	0	0	0	0	0
24 Nov	5	28	68	13	32	41	0	0	0	0	0
26 Nov	5	27	87	4	13	31	0	0	0	0	0
	Total	56	74	20	26	76	0	0	0	0	0

Table 3. Petersen population estimates, confidence limits, and mark-recapture data for adult and jack coho escapement at Zolzap Creek, 1993.

Item	Adults	Jacks [a]	Total
Number coho operculum tagged	775	49	824
Number coho recovered	76	0	76
Number of tagged coho recovered	56	0	56
Petersen estimate	1048	-	1048
Upper 95% CL	1354	-	1354
Lower 95% CL	811	-	811

[a] Petersen estimate not calculated due to lack of recaptures.

Table 4. Freshwater age distribution of adult and jack coho at Zolzap Creek, 1993.

Sex	Age 2		Age 3		Total aged	Total unaged	Total sampled
	No.	%	No.	%			
Jacks	12	80.0	3	20.0	15	4	19
Adult males	39	60.0	26	40.0	65	10	75
Adult females	17	54.8	14	45.2	31	9	40
Total adults	56	58.3	40	41.7	96	19	115

Table 5. Estimates of total escapement of adipose clipped coho to Zolzap Creek, 1993.

	No. examined (A)	No. with adipose clips (B)	Mark rate (C=B/Ax100)	Population estimate (D)	% of population sampled (E=A/Dx100)	Estimated adipose clips (F=B/AxD)
Adult	784	191	24.4	1048	74.8	255
Jack	51	14	27.5	[a]	[a]	[a]

[a] estimate not calculated

Table 6. Contribution of 1992 marked coho smolt migrations to the 1993 escapement at Zolzap Creek and estimated smolt to spawner survival.

	Estimated adipose clips [a]	No. smolts [b]		Contribution to escapement [e]	Smolt to spawner (%) [f]
		adipose clipped [c]	unclipped [d]		
Adult	255	33923	6678	305	0.75

[a] from Table 5

[b] from Nass, 1993a.

[c] not corrected for tag loss

[d] an unknown number of additional unclipped releases were likely.

[e] marked contribution to escapement = estimated adipose clips * (clipped + unclipped) / clipped

[f] % survival = estimated adipose clips / clipped * 100

Table 7. Estimated Canadian commercial harvest of Zolzap Creek CWT coho in 1993 using tag recovery data (Mark Recovery Program, Fisheries and Oceans, Canada).

Tag	Observed CWT catch [a]				Catch-sample ratio [b]			Estimated CWT catch [c]			
code	N. Troll	N. Net	C. Net	Total	N. Troll	N. Net	C. Net	N. Troll	N. Net	C. Net	Total
180925	1	5	0	6	5.0	2.6	0.0	5	13	0	18
180926	2	4	0	6	5.0	2.8	0.0	10	11	0	21
180927	5	6	1	12	5.0	2.7	4.0	25	16	4	45
180928	2	5	0	7	5.0	2.6	0.0	10	13	0	23
Total	10	20	1	31	5.0	2.7	4.0	50	53	4	107

[a] Observed CWT = CWT recovered from the commercial catch

[b] Cumulative catch-sample ratio = total commercial coho catch / total coho sampled

[c] Estimated CWT = observed CWT catch * catch sampling ratio

Table 8. Estimated American commercial harvest of Zolzap Creek CWT coho in 1993 using tag recovery data (Mark Recovery Program, Alaska Dept. of Fish and Game).

Tag	Observed CWT catch [a]			Catch-sample ratio [b]		Estimated CWT catch [c]		
code	Troll	Net	Total	Troll	Net	Troll	Net	Total
180925	18	7	25	2.9	2.3	53	16	69
180926	17	5	22	3.2	2.2	55	11	66
180927	23	11	34	3.2	2.5	74	27	101
180928	25	7	32	2.8	3.3	69	23	92
Total	83	30	113	3.0	2.6	251	77	328

[a] Observed CWT = CWT recovered from the commercial catch

[b] Cumulative catch-sample ratio = total commercial coho catch / total coho sampled

[c] Estimated CWT = observed CWT catch * catch sampling ratio

Table 9. Expanded Canadian and American commercial harvest of Zolzap Creek coho and estimated total return.

Tag code	Total release	Smolts tagged [a]	Mark rate [b]	Expanded catch [c]							Escap.	Total return [d]
				Canadian			American			Grand		
				Troll	Net	Total	Troll	Net	Total	Total		
180925	16107	9536	1.69	8	22	23	68	21	89	112		
180926	5230	5125	1.02	10	11	21	56	11	67	88		
180927	9378	9190	1.02	26	20	46	76	28	104	150		
180928	9886	9299	1.06	11	14	30	88	29	117	147		
Total 1 [e]	40601	33150	1.22	61	70	131	307	94	402	533	305	838
Total 2 [f]			4.10	205	234	439	1029	316	1345	1784	1048	2832

[a] Number smolts released with tags (corrected for tag loss)

[b] Mark rate at release = No. released / No. tagged

[c] Expanded catch = EST * mark rate at release

[d] Total return = expanded catch + escapement

[e] Total 1 expanded catch is calculated using the total mark rate at release and the total estimated catch for all tag codes (from Tables 7 and 8)

[f] Total 2 expanded catch is calculated using the total adipose clip rate at recovery and the total estimated catch for all tag codes (from Tables 7 and 8)

Table 10. Estimated harvest distribution of Zolzap Creek CWT coho by area and gear type, 1993. Percentage is of total harvest.

Area [a]	Net	%	Troll	%	Total	%
Canada						
1	0	0.0	10	2.3	10	2.3
2	0	0.0	5	1.1	5	1.1
3	49	11.3	30	6.9	79	18.2
4	4	0.9	5	1.1	9	2.1
5	0	0.0	0	0.0	0	0.0
6	4	0.9	0	0.0	4	0.9
7	0	0.0	0	0.0	0	0.0
subtotal	57	13.1	50	11.5	107	24.6
U.S.A. (Alaska)						
Northern Outside	0	0.0	23	5.3	23	5.3
Central Outside	0	0.0	82	18.9	82	18.9
Southern Outside	19	4.4	63	14.5	82	18.9
Southern Inside	45	10.3	43	9.9	88	20.2
Central Inside	13	3.0	0	0.0	13	3.0
Southern Intermediate	0	0.0	40	9.2	40	9.2
Stephen Passage	0	0.0	0	0.0	0	0.0
Lynn Canal	0	0.0	0	0.0	0	0.0
Central Intermediate	0	0.0	0	0.0	0	0.0
subtotal	77	17.7	251	57.7	328	75.4
TOTAL	134	30.8	301	69.2	435	100.0

[a] includes respective sub-areas

FIGURES

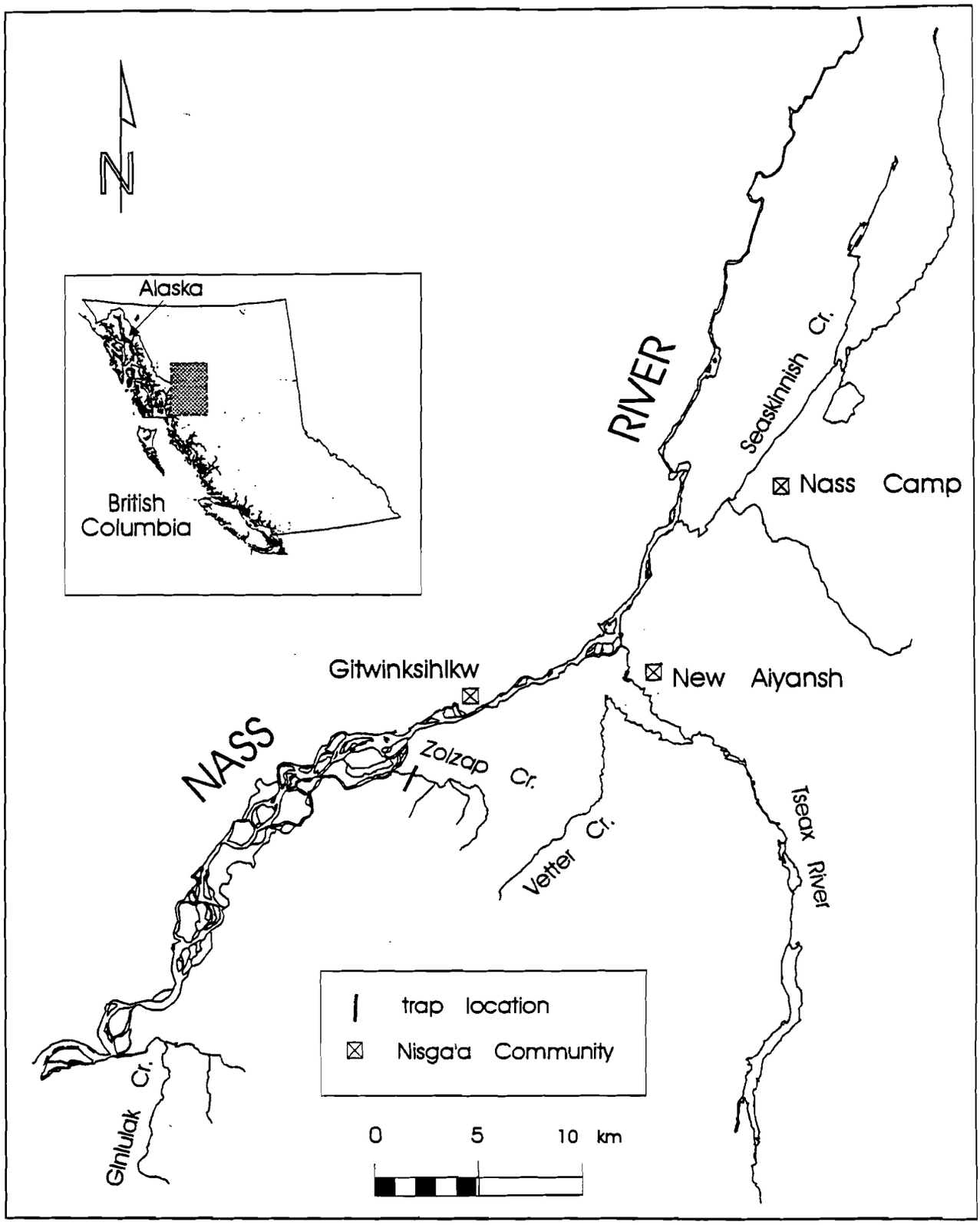

Figure 1. Zolzap Creek and location of adult enumeration fence.

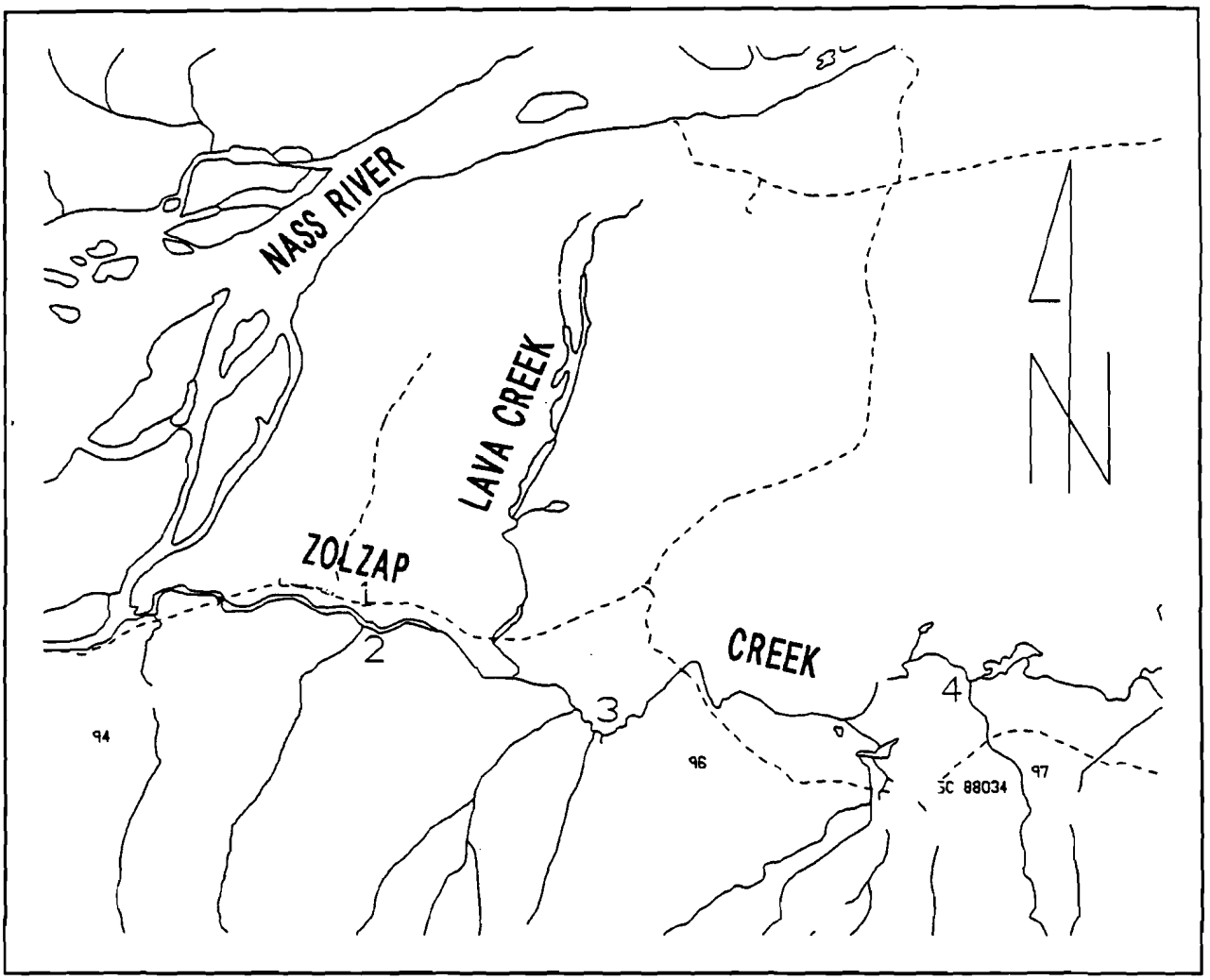

Figure 2. Zolzap Creek and upstream mark-recapture survey sites.

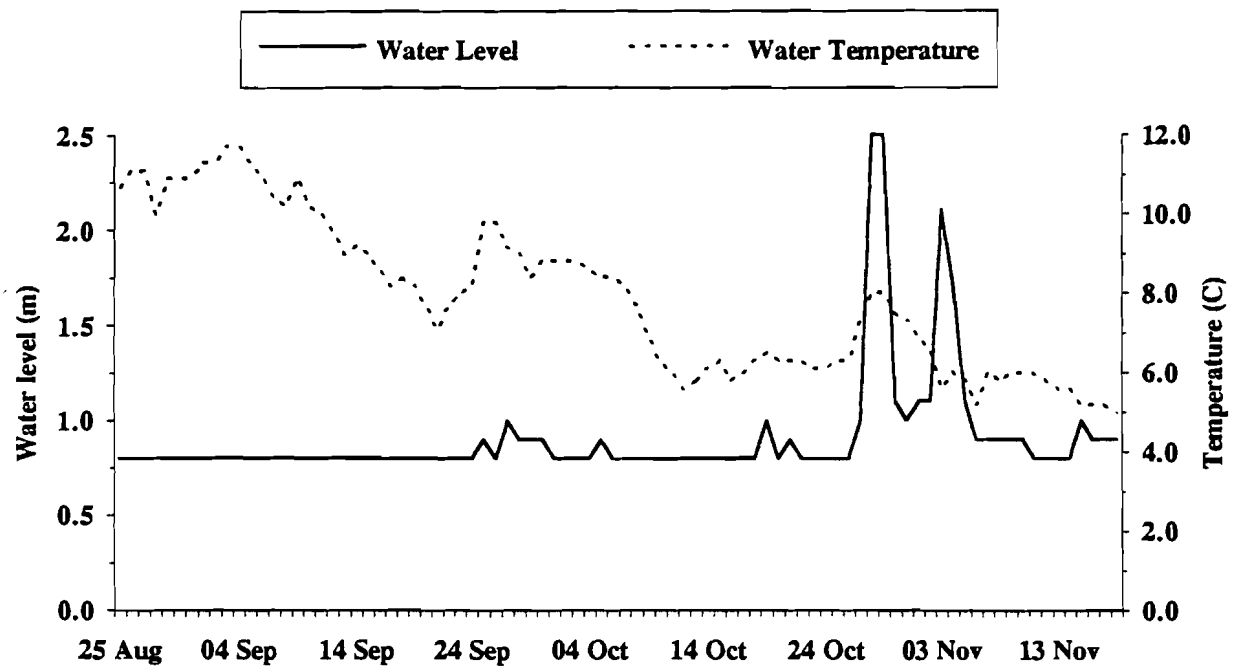

Figure 3. Water level and temperature for Zolzap Creek, 25 August to 19 November, 1993.

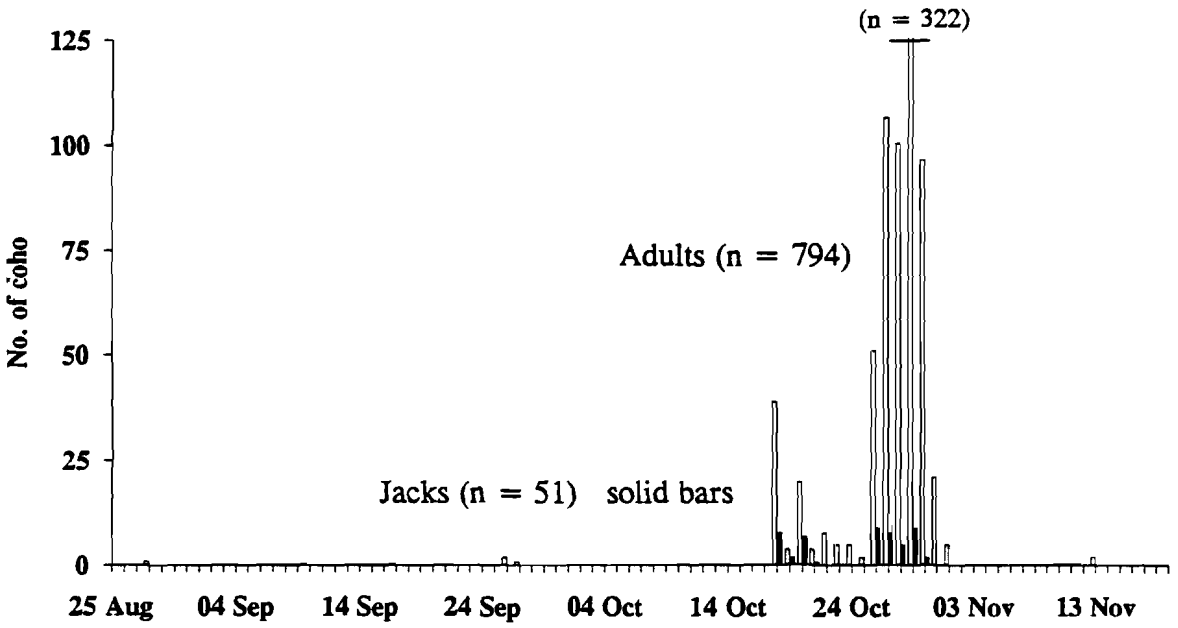

Figure 4. Daily fence counts of adult and jack coho at Zolzap Creek, 1993.

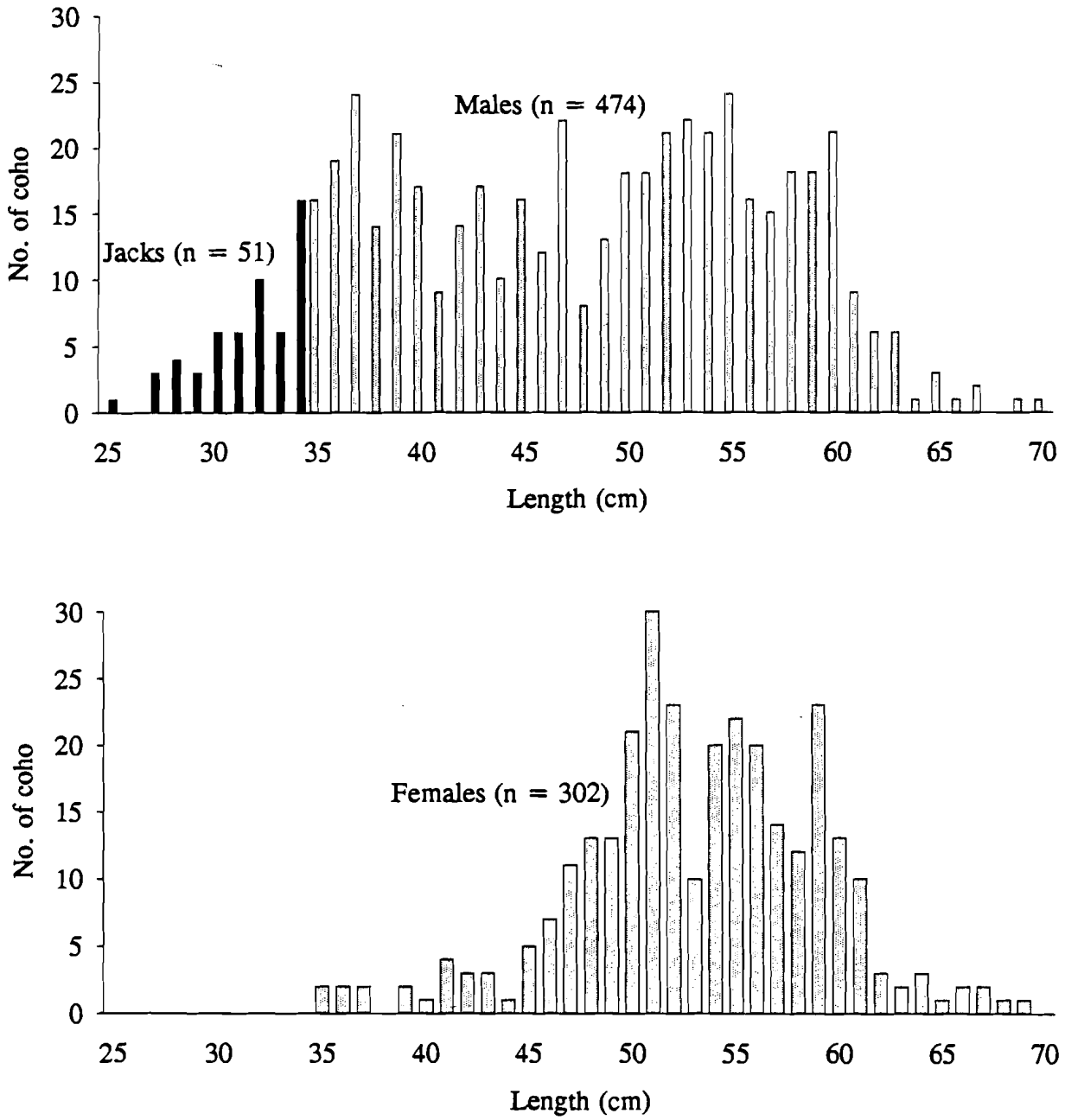

Figure 5. Length-frequency for adult and jack coho at Zolzap Creek, 1993.

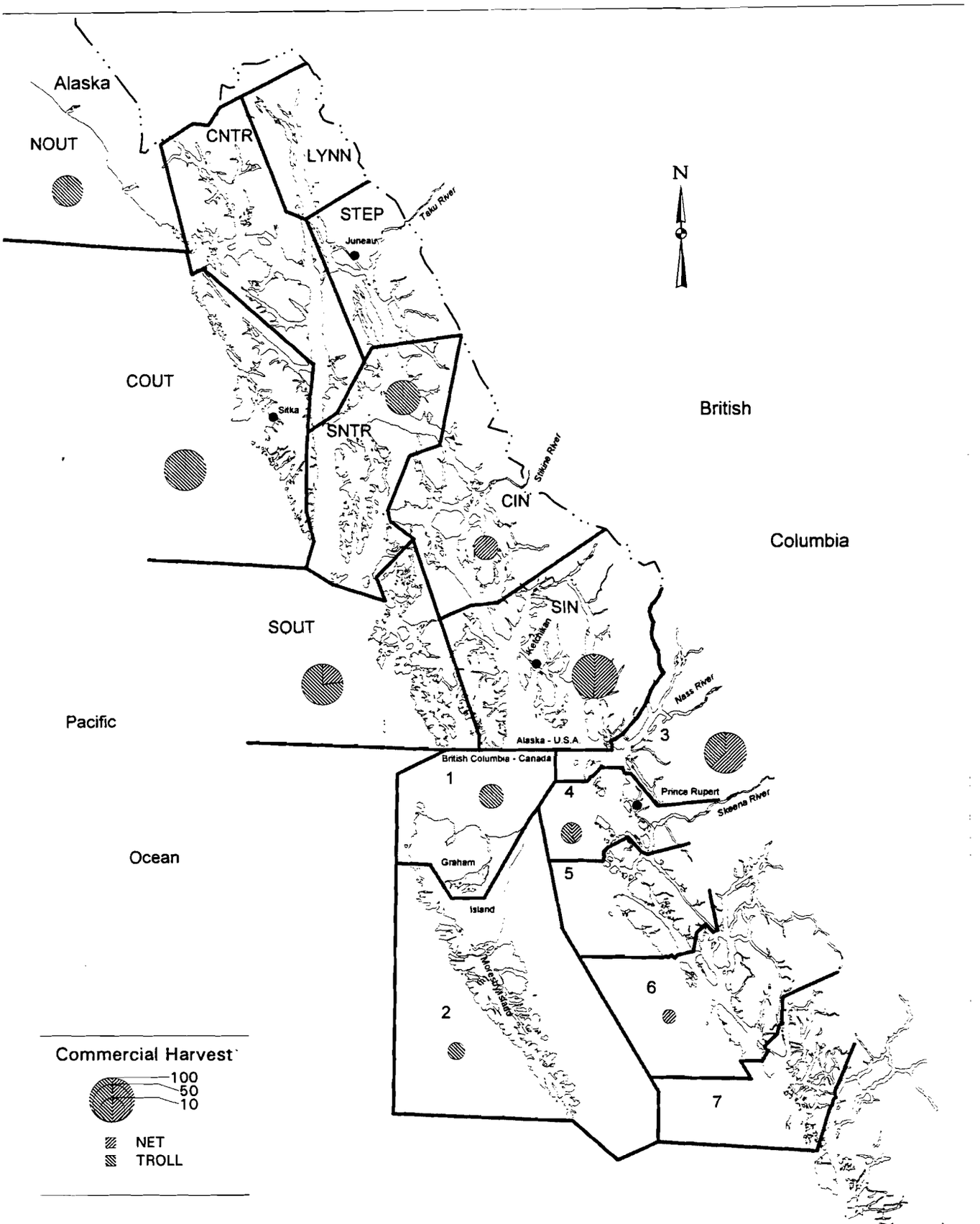

Figure 6. Fisheries Statistical Areas for the north coast of British Columbia and southeast Alaska, and commerical harvest distribution of Zolzap Creek CWT coho, 1993.

APPENDICES

Table A1 - Daily fence counts of adult and jack coho, Zolzap Creek, 1993

Date	Adults		Jacks	
	No. examined	No. tagged	No. examined	No. tagged
25 Aug	0	0	0	0
26 Aug	0	0	0	0
27 Aug	0	0	0	0
28 Aug	1	1	0	0
29 Aug	0	0	0	0
30 Aug	0	0	0	0
31 Aug	0	0	0	0
01 Sep	0	0	0	0
02 Sep	0	0	0	0
03 Sep	0	0	0	0
04 Sep	0	0	0	0
05 Sep	0	0	0	0
06 Sep	0	0	0	0
07 Sep	0	0	0	0
08 Sep	0	0	0	0
09 Sep	0	0	0	0
10 Sep	0	0	0	0
11 Sep	0	0	0	0
12 Sep	0	0	0	0
13 Sep	0	0	0	0
14 Sep	0	0	0	0
15 Sep	0	0	0	0
16 Sep	0	0	0	0
17 Sep	0	0	0	0
18 Sep	0	0	0	0
19 Sep	0	0	0	0
20 Sep	0	0	0	0
21 Sep	0	0	0	0
22 Sep	0	0	0	0
23 Sep	0	0	0	0
24 Sep	0	0	0	0
25 Sep	0	0	0	0
26 Sep	2	1	0	0
27 Sep	1	1	0	0
28 Sep	0	0	0	0
29 Sep	0	0	0	0
30 Sep	0	0	0	0
01 Oct	0	0	0	0
02 Oct	0	0	0	0
03 Oct	0	0	0	0
04 Oct	0	0	0	0
05 Oct	0	0	0	0
06 Oct	0	0	0	0
07 Oct	0	0	0	0
08 Oct	0	0	0	0
09 Oct	0	0	0	0

Table A1 - Daily fence counts of adult and jack coho, Zolzap Creek, 1993

Date	Adults		Jacks	
	No. examined	No. tagged	No. examined	No. tagged
10 Oct	0	0	0	0
11 Oct	0	0	0	0
12 Oct	0	0	0	0
13 Oct	0	0	0	0
14 Oct	0	0	0	0
15 Oct	0	0	0	0
16 Oct	0	0	0	0
17 Oct	0	0	0	0
18 Oct	39	39	8	8
19 Oct	4	4	2	2
20 Oct	20	20	7	7
21 Oct	4	4	1	1
22 Oct	8	8	0	0
23 Oct	5	5	0	0
24 Oct	5	5	0	0
25 Oct	2	2	0	0
26 Oct	51	47	9	7
27 Oct	106	103	8	8
28 Oct	100	100	5	5
29 Oct	322	312	9	9
30 Oct	96	95	2	2
31 Oct	21	21	0	0
01 Nov	5	5	0	0
02 Nov	fence not operational			
03 Nov	fence not operational			
04 Nov	fence not operational			
05 Nov	fence not operational			
06 Nov	fence not operational			
07 Nov	fence not operational			
08 Nov	fence not operational			
09 Nov	fence not operational			
10 Nov	fence not operational			
11 Nov	fence not operational			
12 Nov	fence not operational			
13 Nov	2	2	0	0
14 Nov	0	0	0	0
15 Nov	0	0	0	0
16 Nov	0	0	0	0
17 Nov	0	0	0	0
18 Nov	0	0	0	0
19 Nov	0	0	0	0
Totals	794	775	51	49