Adult and Juvenile Coho Salmon Enumeration and Coded-wire Tag Recovery Analysis for Zolzap Creek, BC, 1999

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Room 202, 417-2nd Ave.
Prince Rupert, BC
V8J 1G8

2002

Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2597

Canadian Manuscript Report of Fisheries and Aquatic Sciences

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Fisheries and Aquatic Sciences 2597

2002

ADULT AND JUVENILE COHO SALMON ENUMERATION AND CODED-WIRE TAG RECOVERY ANALYSIS FOR ZOLZAP CREEK, BC, 1999

prepared by

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Cat. No. Fs 99-4/2597E ISSN 0706-6473

Correct citation for this publication:

Baxter, B.E. and C.Y. Stephens. 2002. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1999. Can. Manusc. Rep. Fish. Aquat. Sci. 2597: viii + 46 p.

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ABSTRACT

Baxter, B.E. and C.Y. Stephens. 2002. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1999. Can. Manusc. Rep. Fish. Aquat. Sci. 2597: viii + 46 p.

Adult and juvenile coho migrations were monitored at Zolzap Creek, British Columbia, as part of the 1999-2000 Nisga'a Fisheries Program. The 1999 season is the eighth year of continuous operation of the Zolzap Creek fences since 1992. This report includes eight year summaries of the most pertinent data. Smolt trapping was conducted from 20 April to 13 June 1999 using an in-stream wire-mesh fence. A total of 15,153 coho smolts were captured during the trapping period, and an unknown number migrated out during periods when the fence was not operational. Of those captured, 14,591 were released with coded-wire tags. Migration timing, mean length and weight at age, and age composition are presented.

Adult coho escapement was monitored using an in-stream fence and carcass surveys. The counting fence was operational between 26 August and 21 October. A total of 1,302 adult coho were counted at the fence with an estimated escapement of 1,393 using the adjusted Peterson model. Adipose-clip rate was 34.9% for adult coho. Age and length characteristics of adult males and females are presented.

Canadian and US commercial harvests were examined using coded-wire tag recovery data obtained from the Mark-Recovery Program and the Alaska Department of Fish and Game (ADF&G) mark tag and age lab online searchable database. Total commercial exploitation rate on Zolzap Creek coho in 1999 was 49.5% (1.2% Canadian, 48.3% US). Of the total commercial catch of Zolzap Creek coho, Canadian catch accounted for 2.1% and the US catch accounted for an estimated 97.9%. Harvests occurred over a wide area ranging from SE Alaska to the US Northern Outside Statistical Area in Alaska (northwest of Juneau, AK). Due to concerns over declining coho stocks, the Canadian fishery was shut down for coho harvests this year. Limited Canadian harvests occurred in Areas 1-5 for the net fishery. US harvests of Zolzap coho in Alaska were largest in the Southern Inside Statistical Area for the net fishery and the Central Outside Statistical Area for the troll fishery. Total survival was 7.0% and smolt-to-spawner survival was 3.5%.

RÉSUMÉ

Baxter, B.E. and C.Y. Stephens. 2002. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1999. Can. Manusc. Rep. Fish. Aquat. Sci. 2597: viii + 46 p.

Les migrations de saumons coho, adultes et jeunes, ont été mesurées au ruisseau Zolzap en colombie-britannique, dans le cadre du programme des pêcheries des Nisga's en 1999-2000. La saison 1999 marque la huitième année d'opération continue des barrières du ruisseau Zolzap depuis 1992. Ce rapport contient les sommaires des données les plus intéressantes pour les 8 dernières années. Le piégeage des saumoneaux prit place entre le 20 avril et le 13 juin 1999 à l'aide d'une barrière en fil métallique installée dans le ruisseau. En tout 15,153 saumoneaux coho furent capturés pendant la période de piégeage tandis qu'un nombre inconnu a migré quand la barrière n'était pas opérationelle. Sur l'ensemble des saumoneaux capturés, 14,591 ont été remis à l'eau avec une marque magnétique codée. Nous présentons la période de migration, la longueur et le poids moyens selon l'âge ainsi que les groupes selon l'âge.

La remonte de saumons coho adultes a été surveillée grâce à une barrière installée dans le ruisseau et à l'observation des carcasses. La barrière de comptage fut opérationelle entre le 26 août et le 21 octobre. Un total de 1,302 saumons coho adultes ont été dénombrés à la barrière avec une migration estimée à 1,393 en utilisant le modèle rajusté Peterson. Le taux d'ablation de la nageoire adipeuse était de 34.9% pour les saumons coho adultes. Nous présentons les caractéristiques d'âge et de longueur pour les males et les femelles adultes.

Les récoltes commerciales canadiennes et américaines ont été examinées grâce aux données de récupération des marques magnétiques codées provenant du programme de marquage-récupération et en directe de la base de données du département de Pêche et Chasse de l'Alaska. En 1999 le taux total d'exploitation du saumon coho au ruisseau Zolzap fut évalué à 49.5% (1.2% pour le Canada, 48.3% pour les Etats-Unis.) Sur le total de prises commerciales de saumon coho au ruisseau Zolzap, le Canada en comptait 2.1% et les Etats-Unis, une estimation de 97.9%. Les récoltes couvraient un vaste secteur, s'étendant à partir du sud-est de l'Alaska jusqu'à la zone statistique nord extérieure de l'Alaska (au nord-ouest de Juneau AK). A cause de soucis concernant le déclin des stocks de coho, pour cette année une fermeture fut imposée sur la pêche canadienne. La récolte du saumon coho au Canada fut limitée dans les zones 1 à 5 pour la pêche au filet. La récolte par les Etats-Unis en Alaska des saumons coho du Zolzap fut plus nombreuse dans la zone statistique sud intérieure pour la pêche au filet, et, dans la zone statistique centrale extérieure pour la pêche à la traine. Le taux total de survie fut 7.0% tandis que pour les saumoneaux/géniteurs le taux de survie fut 3.5%.

INTRODUCTION

As part of the Aboriginal Fisheries Strategy (AFS) a program was established for fisheries research in the Nisga'a Traditional Territory, British Columbia. One component of this large research initiative focused on the assessment of juvenile and adult coho populations in tributaries to the Nass River. Juvenile and adult coho enumeration studies have been conducted on Zolzap Creek since 1992 (Nass 1996a; Nass 1996b; Nass and English 1994; Nass 1996c; Nass 1997a; Nass 1997b; Nass 2001; Nass and Frith 2001; Baxter et al. 2001). This report presents results for studies conducted at Zolzap Creek in 1999.

The objectives of the research were to:

1. Enumerate migrating juvenile coho and estimate escapement;

2. Document the timing, size, and age distribution of migrating coho;

3. Mark coho smolts with coded-wire tags (CWT) to enable the determination of oceanic harvest rates;

4. Monitor the escapement for marked CWT adult coho, and determine oceanic exploitation and survival rates; and

5. Collect water temperature and level data for future examination of the relationships between physical environmental factors and coho smolt migration timing, and between adult escapement and smolt production.

Achievement of these objectives involved the construction and operation of in-stream, semi-permanent, panel fences located approximately 0.5 km upstream of the mouth of Zolzap Creek.

STUDY STREAM

Zolzap Creek is a tributary to the Nass River, located in northwestern British Columbia (Figs. 1 and 2). Zolzap Creek flows for 6 km in a northwesterly direction between Nisga'a Lava Bed Memorial Park and the Kitimat Mountain Range to its confluence with the Nass River, 5 km downstream of Gitwinksihlkw. The main channel of the creek is regularly interrupted by beaver dams and log jams. The substrate is highly variable and ranges between silty particulate, to granite cobble, and coarse pumice. Major flow contributions come from Lava Creek (3 km in length) which flows from the lava beds and numerous small creeks that flow from the steep alpine. Intermittent flows of water from the Nass River and Vedder Creek are possible during flooding periods. The mouth of Zolzap Creek enters a side channel to the Nass River known as Zolzap Slough. The lower 0.5 km of Zolzap Creek regularly becomes inundated when water levels on the Nass River are high. Zolzap Creek supports many species of salmonids including coho (*Oncorhynchus kisutch*), pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), rainbow (*O. mykiss*), cutthroat (*O. clarki*), and Dolly Varden (*Salvelinus malma*). Non-coho species

include lampreys (family Petromyzontidae), sticklebacks (family Gasterosteidae), and sculpins (family Cottidae). Coho escapement was estimated to be 1,561 in 1992 (Nass 1996b), 1,048 in 1993 (Nass 1996c), 2,536 in 1994 (Nass 1997a), 908 in 1995 (Nass 1997b), 1,039 in 1996 (Nass 2001), 470 in 1997 (Nass and Frith 2001), and 967 in 1998 (Baxter et al. 2001).

JUVENILE COHO STUDIES

METHODS

Trapping Operations

An in-stream, semi-permanent enumeration fence was located 0.5 km upstream of the creek mouth for the capture of downstream migrating coho smolts. Fence design was based on Conlin and Tutty (1979) and minor modifications were required due to site characteristics and available materials. The fence was built in a W-pattern and spanned the entire creek bed. Three by eight foot panels constructed of 2"x 4"s and covered with ¼" wire-mesh were laid on their long side in the creek bed to form the fence. Rebar of ⅜" and ½" diameter were used to anchor the panels to the stream bed. A second layer of panels were installed on top of the first row of panels to create a fence with a total height of six feet. Burlap sandbags and heavy duty plastic garden sheeting were used to seal the base of the panels. Two hinged panels were installed in each of the fence wings for release of excess water in the event of flooding. Plywood trap boxes with Vexar-screened windows (to allow water exchange) were anchored at each down-stream apex and were connected to the fence with 8" Big-O tubing. Additional boxes were made for holding fish after processing and were designed with a small door for releasing fish. Provisions for upstream migrating adults were made by constructing a simple trap consisting of a wire-mesh panel extending out from the stream bank to one wing of the fence. Plywood was used to cover the adult trap area.

Juveniles were captured using roe baited gee traps when the fence was inoperable due to flood conditions. During periods of low water, seining was used to supplement fence catches.

Physical Observations

Crews monitored water temperatures, water levels, and weather daily. Crews recorded temperature to the nearest degree (1 °C) using a maximum-minimum thermometer and water level using staff gauges calibrated to the nearest cm (0.01 m). A total of three staff gauges were used; two were located within 50 m of the trapping site (one upstream, one downstream of the fence) and one approximately one kilometre upstream of the fence. Precipitation was recorded on a scale of zero to five with zero representing no precipitation and five being heavy precipitation.

Fish Enumerations

Daily numbers of coho smolts captured at the fence were obtained from automatic counters on coded-wire tagging machines or by manual counts. The number of fence mortalities was added to the total count. Coho juveniles with standard lengths greater than or equal to 70 mm were identified as smolts. Coho smaller than 70 mm tended to be dark with distinct parr marks and lacked the silver colouration typical of smolts. Therefore, this group consisted of pre-smolts and fry. All coho pre-smolts and fry, and non-coho species were counted and released downstream of the fence during sorting. Upstream migrating juveniles caught in the adult traps were counted and released upstream.

Biosampling

A random sample of up to 25 smolts (i.e., coho greater than or equal to 70 mm) were obtained from each day's catch. These smolts were anaesthetized and measured for fork length and weighed using an electronic scale (0.1 g). Scale sampling followed the stratified method of Ketchen, described by Ricker (1975); age sample data (column X on Table 1) included non-random samples, and length sample data (column Y on Table 1) and the calculated age representation was based on random sampling. Crews attempted to collect at least 10 scale samples from each 5 mm size class of coho for the study period. Smolts from under-represented size classes were selected to supplement random samples. Mean length and weight data was determined by multiplying the mean length and weight data for each 5 mm bin class by the total number of length and weight samples in that bin class (factor) to come up with a weighted mean length and weight for that bin class. The average length and weight for all sampled fish was determined by summing all the weighted length and weight measurements and dividing by the overall sum of the factors. Scale samples were interpreted by the Fisheries and Oceans Canada Scale Lab, Nanaimo, BC. Secondary quality control checks were performed to ensure a reliable age designation. Scale ages are reported in Gilbert-Rich notation where freshwater age-2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Biosampling was also conducted on a sub-sample of cutthroat and steelhead trout and sockeye. Length, weight, scales and DNA tissue samples were obtained from adults and juveniles. No data or analysis are presented here, but the data can be obtained from the principal author.

Coded-wire Tagging

Coded-wire tagging at Zolzap Creek was performed using a Mark IV tagging machine (Northwest Marine Technology Ltd. Shaw Island, WA). Smolts were anaesthetized in a MS222 bath prior to tagging. All tagged fish were adipose-fin clipped (AFC). The numbers of coho smolts tagged with each tag code and the number of smolts untagged were recorded. All tagged smolts were placed in a holding box in the stream and allowed to recover from the tagging operation before release.

Tag retention tests were conducted for each tag code. A sample of tagged coho smolts (minimum of 200 smolts) were retained in a holding box from 24 h to 96 h. Following the holding period, smolts were lightly anaesthetized and checked for the presence of a coded-wire tag using the quality control device (QCD) from the coded-wire tagging machine. Coho smolts not possessing a tag were checked a second time. The total number of tags detected for each tag group and the total number of fish tested was recorded.

RESULTS

Physical Observations

Water temperatures during the smolt migration period at Zolzap Creek ranged from a minimum of 4 °C in late April to a maximum of 8 °C in mid-June (Fig. 3A). Water level at gauge 2 (50 m upstream of the fence) remained steady at a gauge height of 0.3 m from the beginning of monitoring on 20 April until 22 May. Water level rose sharply to 1.5 m within one day following 22 May and then dropped to 0.5 m on 27 May. Water levels continued to remain steady at approximately 0.5 m until 9 June at which time levels began to increase rapidly, flooding the fence on 13 June, ending the spring monitoring period. High water levels in Zolzap Creek occur when the Nass mainstem flow rises causing water to back-up into the creek. Water flow in Zolzap Creek declines to very low velocities during these flooding events.

Fish Enumerations

The Zolzap Creek juvenile counting fence was operated from 20 April to 13 June 1999. Seining was used to supplement catches at the fence during periods of low water. In addition, approximately 25 to 30 baited gee traps were used during high water periods.

Coho Smolts: A total of 15,153 coho smolts were counted at the fence and included approximately 2,000 coho smolts captured using baited gee traps (Table 2). The maximum daily number of smolts captured at the fence was 1,922 and occurred on 24 May (Table A-1, Fig. 4). An unknown number of smolts moved past the trapping location after the fence was flooded. An additional 850 smolts were estimated to have left the system based on the pattern of migration. There were a total of 1,857 fry and pre-smolt coho counted and released during trapping operations and 59 mortalities (Table A-1).

Non-coho Species: Lampreys (larvae and young adults) were caught in the largest numbers followed by juvenile Dolly Varden, juvenile sockeye, and juvenile cutthroat (Table 3, Table B-1).

Biosampling: Length, Weight, and Age

The mean fork length of age-2 smolts was 103.2 mm and the mean weight was 11.1 g (Table 1). Age-3 smolts averaged 114.5 mm and 14.9 g and age-4 smolts averaged 131.3 mm and 21.5 g. The length-frequency distribution showed substantial overlap between age-2 and age-3 coho (Fig. 5). Age-2 smolts were most numerous in the 100 - 105 mm length class and

age-3 smolts were most numerous in the 110 - 115 mm length class. Age-3 coho smolts were significantly larger than age-2 smolts (t-test, $p < 0.05$). Overall, coho smolts averaged 108.4 mm in length. The calculated freshwater age structure of coho smolts was 56.8% age-2, 41.4% age-3 and 1.6% age-4 (Table 1).

Coded-wire Tagging

Mean tag retention was 100% for tag code 18-43-12 and 99.5% for tag code 18-43-13 (Table 4). Crews conducted twelve tests for tag code 18-43-12 for a total of 2,027 samples with no tag losses and four tests for tag code 18-43-13 for a total of 800 samples and a total of 4 tag losses.

Releases of adipose-fin clipped coho totalled 14,591 (Table 5; Table C-1). Crews recorded 106 mortalities associated with the tagging process. The total number of coho smolts released with coded-wire tags was 14,572. Approximately 1.6% (233) of the captured coho smolts were released untagged during the study period and thus the mark rate of coho smolts released was 1.02 (Table 5). The total number of smolts released was 14,824.

ADULT COHO STUDIES

METHODS

Population Estimates

An aluminum conduit fence anchored to a crib-type sill was constructed at Zolzap Creek. All salmonids caught at the fence were counted and classified by sex. Sex was distinguished on the basis of length and body morphology. Previous studies at Zolzap Creek (Nass 1996b, 1996c, 1997a, 1997b, Nass 2001, Nass and Frith 2001, Baxter et al. 2001) have shown an absence of jacks in the escapement, and therefore all males were classified as adults. "Jack panels" consisting of one inch wire mesh were used to prevent the passage of small coho through the fence and were used whenever water levels and debris permitted. Each coho was tagged on the operculum with a uniquely numbered Ketchum kurl-lock tag and measured 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 captured fish were released upstream of the fence.

Adult coho abundance downstream of the fence was assessed later in the migration period due to the lack of fish movement past the fence. Delayed migration was the result of persistent low water conditions in Zolzap Creek in the later fall period. During these periods of delayed fish movement, angling was conducted approximately 1 km downstream of the fence in Zolzap Slough to determine relative coho abundance. Coho were examined for sex and AFC's, and a uniquely numbered opercular tag was applied. All fish captured were released back into Zolzap Slough. Live coho were recaptured in upstream surveys and checked for operculum tags. Carcasses were recovered on the fence and during upstream surveys. In 1999, carcasses were recovered primarily in the lower 5 km of the creek.

Biosampling

All live coho captured at the fence were measured for postorbital-hypural length and examined for fin clips and sex. Data recorded from coho captured at the fence were used to calculate sex ratios and mean length by sex. Crews attempted to sample at least 25 coho a day for scales (5 scales per fish). Scale samples were sent to the Fisheries and Oceans Canada scale lab, Nanaimo, BC for age determination. Secondary quality control checks were performed at the scale lab to ensure reliability of the age designations. Scale ages are reported in Gilbert-Rich notation where freshwater age-2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Adult returns (calculated by escapement method) and smolt production, by CWT and total populations, were calculated for each brood year where data was available. Smolt output and adult escapement were apportioned between brood years (back-calculated) using the age structure observed in the respective yearly migrations. The sum of freshwater age-2, age-3, and age-4 individuals equals total production for a given brood year. Age composition for smolts and adults by brood year were calculated based on the estimated production. Total survival by brood year was calculated as the age specific adult return divided by the respective smolt production. The smolt-to-spawner ratio for each brood year was calculated as the number of smolts produced divided by the number of adults in the escapement, by brood year. Similarly, the recruit-to-spawner ratio for each brood year was calculated as the number of adults produced divided by the number of adults in the escapement, by brood year.

Coded-wire Tag Recoveries

Coded-wire tagged smolts were AFC prior to release. Coho smolts at Zolzap Creek were CWT in the spring of 1998 (Baxter et al. 2001) during out-migration.

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) and modified in Nass (1997a). CWT heads were collected from fish captured at the Nass River fishwheels, fish recovered in the native angling fishery below the fence, and from carcass recoveries.

Commercial and Sport Harvests: Commercial and sport catches of CWT fish are monitored by the Fisheries and Oceans Canada and various US agencies and compiled in the Mark Recovery Program (MRP) and in the ADF&G mark tag and age lab online searchable database. 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 spatial and temporal distribution of harvests (Kuhn et al. 1988, Nass 1997a). The estimates include catch (observed catch corrected for sampling effort), expanded catch (estimated catch corrected for unmarked fish), exploitation rate (proportion of CWT coho caught in the fishery), and total return (expanded catch plus escapement).

Geographic Distribution of Harvest: Coded-wire tagged fish in the commercial catch are recorded by Canadian and US fishery Statistical Areas. To estimate number of recoveries for each Canadian area, the observed CWT catch was expanded by the mean catch-sampling ratio observed in the Catch Region (e.g., Northern Troll = Stat Areas 1, 3, 4, and 6). Similarly, US troll catch was expanded using the catch sampling ratio by quadrant (e.g., northwest) and the net catch sampling ratios, by district.

RESULTS

Physical Observations

During the period that the adult fence was operational, water temperatures ranged from a maximum of 10 °C in early September to a minimum of 3 °C in mid October (Fig. 3B). Water level ranged from 0.3 m during base flows to 0.7 m during freshets (Fig. 3B).

Adult Enumerations

The fence was operated continuously from 26 August to 21 October. A total of 1,302 adult coho salmon were counted at the fence (Table 6). Of these, 1,221 adults (adjusted for tag loss) were operculum tagged and released upstream. Maximum daily migration past the fence was 375 adults on 20 October (Table D-1) (Fig. 6).

Coho population assessments below the fence were conducted on 10, 12, 13 September and 7 October. A total of 29 coho were captured using angling. All coho were sexed, opercular tagged and checked for AFC's. Of the 29 tagged coho released, none were recaptured below the fence during the surveys, and 15 (52%) were observed at the fence. Therefore, at least 14 coho remained below the fence.

For non-coho species captured at the fence, Dolly Varden had the greatest abundance (174), followed by pink (71), and chum (32). Cutthroat (28), sockeye (11), and steelhead (1) were also captured at the fence (Table 3). Chum and pink were caught in their greatest numbers in mid-September and sockeye were caught mainly in late September. Cutthroat and Dolly Varden were mainly caught in mid-October. The number of chum and sockeye caught in 1999 were greater than in 1998. The number of cutthroat and Dolly Varden were also more than in 1998. No population estimates were derived for non-coho species.

Mark-recapture Estimates

Crews examined a total of 186 adult coho carcasses collected on the fence, and in 13 upstream surveys. Surveys were conducted upstream of the fence from 19 October to 1 December at three access locations along the creek. Upstream surveys were conducted on 19 October, and 1, 5, 9, 16 November and 1 December at Goat Creek (a tributary); 26, 28, 30 October, and 3, 7, 12, 23 November at upper Zolzap Creek. Of the 186 adult coho examined, 163 were tagged and 9 had lost their tags which resulted in an estimate of 1,393 adults escaping to Zolzap Creek in 1999 (Table 6).

Biosampling - Age and Length

A total of 302 coho were sampled for scales, of which 256 were successfully aged (Table 7). Unaged samples included marine regenerates. Adult males and females had different age compositions which averaged 72.3% and 64.8% freshwater age-2, and 27.7% and 35.2% freshwater age-3, respectively. The total age composition was 69.1% age-2 and 30.9% age-3. All aged scales were recorded as marine age 1 (i.e., having 1 marine annulus).

Mean lengths of adult males and females were 46.6 cm (n=713, SD=8.8) and 52.4 cm (n=574, SD=4.5), respectively. Adult male coho were widely distributed over the range of 26 to 67 cm with a mode of 53 cm (Fig. 7). Female coho had a mode of 53 cm with a range of 37 to 65 cm. For coho sexed during processing, adult males captured at the fence (n=713) were more abundant than females (n=574).

Coded-wire Tag Recoveries

Escapement: Crews examined 1,294 adult coho at the fence for fin clips of which 451 were AFC (34.9%; Table 8). An estimated 486 adipose clipped adult coho returned to Zolzap Creek in 1999. In addition, of the 29 coho examined below the fence, 6 (21%) were AFC. Of the 6 AFC coho tagged below the fence, 2 were observed at the fence. Therefore, at least 4 AFC coho remained below the fence. Smolt to spawner survival (i.e., includes natural and harvest mortality) for adult coho was estimated at 3.5%.

Thirty-five (35) CWT heads were collected at Zolzap Creek. Of these recoveries, 6 were from the native angling fishery below the fence and 29 were from carcass recoveries. In addition, 4 coho with adipose clips were recovered at the Nass River fishwheels. A total of 31 CWT recoveries from Zolzap Creek were from the 1998 release at Zolzap Creek (code 28-16-21), 1 was from the 1997 release at Zolzap Creek (code 28-16-20) and 3 were No-Pin. Of the 4 fishwheel CWT recoveries, 2 were from the 1998 release at Zolzap Creek (code 28-16-21), and 2 were No-Pin.

Commercial and Sport Harvests: Total observed Zolzap Creek coho CWT recoveries were 4 and 158 for Canadian and US (Alaska) fisheries, respectively (Table 9). Observed sport recoveries totalled 1 for the Canadian fisheries and 5 for the Alaskan fishery. All CWT recoveries were from the 1998 release year. Northern Canadian net catch-to-sample ratio was 1.0, while US troll and net ratios were 2.9 and 2.8, respectively (Table 9). Estimated Zolzap Creek CWT coho catches were 9 (1.9%) and 473 (98.1%) for Canadian and US fisheries, respectively (Table 9).

Expanded Canadian and US catches were 10 and 535, respectively, for a total of 545 using the CWT mark ratio at release (i.e., MRP method) (Table 10). Expanded Canadian and US catches were 25 and 1,358, respectively, for a total of 1,393 using the adipose-clip ratio at recovery (i.e., escapement method). Estimated total adult return for Zolzap Creek coho was 1,092 and 2,776 using the MRP and escapement methods, respectively (Table 10).

Of the total commercial catch of Zolzap Creek coho, Canadian fisheries accounted for 0.7% and the US accounted for 99.3% of the total commercial catch of Zolzap Creek coho (Table 11). US troll and net fisheries accounted for 80.3% and 19.7% of the total US catch, respectively, while Canadian net fisheries accounted for 100% of the total Canadian catch. Commercial harvest of Zolzap Creek coho occurred over a wide area ranging from Canadian Statistical Areas 1-5 to the US Northern Outside Statistical Area in Alaska (Fig. 8). US harvests were largest in the Southern Inside Statistical Area for the net fishery (10.6%) and the Central Outside Statistical Area for the troll fishery (35.1%; Table 11).

Total exploitation rate (Canadian and US combined) on Zolzap Creek coho in 1999 was 49.2% (Table 12). Total Canadian exploitation rate was 1.2% (net) and total US exploitation rate was 48.3% (39.0% troll, 9.3% net). Total survival based on CWT returns was 7.0% (Table 12).

DISCUSSION

Over the past eight years of monitoring, the average number of smolts estimated leaving Zolzap Creek was 29,250 (Table 12). For the same time period, the average age composition of the smolt population was 57.4% age-2, 41.2% age-3, and 1.4% age-4.

Adult coho enumerated at the fence in 1999 (1,302) accounted for 93.5% of the Peterson population estimate (1,393). Therefore, approximately 91 adults entered Zolzap Creek during the period in which the fence was not operational. An undetermined number of coho were observed spawning below the fence. The native fishery harvested 23 coho below the fence of which 6 were CWT. Average escapement estimates for 1992 - 1999 was 1,240 (Table 12).

Data from 1992 to1997 have indicated that there are no jacks in the Zolzap Creek escapement (Nass 1996b, 1996c, 1997a, 1997b, 2001, Nass and Frith 2001, Baxter et al. 2001). In 1999, CWT and scale ageing data have confirmed again the absence of jacks in the population. There were 39 heads taken for CWT sampling from coho measured between 28 and 63 cm (post-orbital-hypural) and 33 were found to be from 1998 releases and 1 was found to be from the 1997 releases. Only 1 of the samples recovered was from a coho measuring less than 35 cm. This length has been used in previous studies at other BC streams to designate jacks in the escapement and is based on CWT analysis. Both the CWT analysis and scale ageing show that coho less than 35 cm from Zolzap Creek in 1999 were marine age-1.

The Department of Fisheries and Oceans, Canada operates a juvenile and adult fence site at Lachmach River, BC which is used as a Northern BC wild coho indicator stock. Exploitation rates for Lachmach coho have ranged from 44.5% to 70% for the 1994-1999 period (Holtby et al 1999, Barry Finnegan, PBS, Nanaimo, pers. comm.). These exploitation rates are very similar to Zolzap exploitation rates for the same time period (Fig. 9). Total survival for Lachmach coho has ranged from 5.5% (1997) to 17.4% (1994) and has been consistently higher than Zolzap Creek survivals (Fig. 10).

In Alaska, comprehensive information exists for several southeast stocks, including Hugh Smith Lake (Southern Inside Statistical Area, see Fig. 8), which has been monitored since 1982. Preliminary data for the 1999 return suggests exploitation rates of 0% Canadian and 70.2% US (70.2% total; Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.). Southeast Alaska and Canadian fisheries accounted for approximately 100% and 0% of the commercial catch of Hugh Smith coho, respectively. The total exploitation rate on Hugh Smith coho was substantially higher than exploitation rates of 0.7% Canadian and 48.5% US (49.2% total) on Zolzap Creek coho in 1999 (Fig. 9). Preliminary CWT data for the 1999 return of Hugh Smith coho suggest a survival rate of 14.0% which is substantially higher than for Zolzap Creek coho at 7.0%. Hugh Smith coho have had substantially higher survivals (1998: 11.4%, 1997: 8.2%, 1996: 17.9%, 1995: 13.7%, 1994: 19.4%, 1993: 13.0%) compared to Zolzap coho (1998: 3.1%, 1997: 2.4%, 1996: 6.6%, 1995: 3.6%, 1994: 8.9%, 1993: 2.1%) in the past 6 years.

Zolzap Creek CWT coho have been subjected to total exploitation rates between 46.0% and 72.3% and have had total survival rates between 2.1% and 8.9% over the period 1993 to 1999 (Table 12, Figs. 9, 10). Canadian fisheries have had exploitation rates between 0% and 21.4% on Zolzap CWT coho, while US fisheries ranged between 39.2% and 54.8% (Fig. 11). Of the total commercial catch of Zolzap Creek coho, Canadian fisheries have averaged 17.6% and the US has averaged 82.4%, over seven years (Table 12).

Total smolt production by brood year averaged 30,494 (1990 - 1995) and was composed primarily of freshwater age-2 fish (62.1%; Table 13). Adult production by brood year averaged 3,573 (1990 - 1995) and was 52.6% age-2 fish. Age composition at return was substantially different from that observed in the respective smolt populations and varied widely. Freshwater age-4 fish were absent from all adult escapements. Total survival by brood year of all Zolzap coho (unmarked + CWT) averaged 11.9% (1990-1995; Table 13). Total survival of Zolzap CWT coho was substantially lower at 4.4%. Higher survival for all coho compared to CWT coho is likely due to a significant number of unmarked smolts leaving Zolzap during non-operational periods (Nass 1996c). The effects of these conditions are evident from the historical data which shows the AFC at release has been roughly three times that of the AFC rate at return for the period 1993-1999 at Zolzap Creek (Table 8). Therefore, by using only CWT fish, the uncertainty around the number of fish released is eliminated and produces a more accurate estimate of survival.

Estimates of total survival and exploitation are based on the assumption that all CWT coho are recovered in fisheries or on the spawning grounds. At Zolzap Creek, it is possible that the escapement of AFC coho is underestimated due to straying. Coho are known to spawn downstream of Zolzap Creek in Zolzap Slough (a side channel to the Nass River) where some CWT coho may return. In addition, a total of four adipose clipped coho were recovered in the fishwheels above Zolzap Creek in 1999 which tends to confirm our theory of straying. Straying would affect Zolzap Creek survival and exploitation estimates by underestimating survival and overestimating exploitation rates.

Zolzap Creek coho survivals may also be lower than Lachmach and Hugh Smith coho due to predator/prey interactions, with Zolzap Creek coho being more vulnerable to predation during their outmigration. Large river systems that broadcast smolts in lower densities from several areas may be less susceptible to predation than smaller river systems (eg: Zolzap Creek) that have concentrated smolts and therefore a better developed predator community (Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.).

The number of smolts per spawner was 21.7 for the 1995 brood year. This value is conservative as the number of smolts released was likely underestimated. The number of recruits per spawner was 1.7 for the 1995 brood year.

ACKNOWLEDGMENTS

The cooperation of many people was essential in meeting the objectives of this study. Special thanks go to Leonard Squires for monitoring all aspects of operations as crew supervisor. Peter "Normy" Squires, Carol Benson, Tim Angus, Kevin Small, and Lawrence Stephens assisted in constructing and operating the fence. Karl English and Bob Bocking provided technical support and Bob Bocking reviewed the manuscript. Doug Herriot of the Department of Fisheries and Oceans provided the CWT catch data from the Mark Recovery Program. Barry Finnegan (PBS, Nanaimo) provided Lachmach data. Leon Shaul of the Alaska Department of Fish and Game provided Hugh Smith data and helpful comments and suggestions. Robin Tamasi provided mapping support. Funding for this project was provided by the Canadian government as part of the Nisga'a-Canada (Aboriginal Fisheries Strategy) Contribution Agreement (CA99-139).

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TABLES

Table 1. Age - length distribution of Zolzap Creek coho smolts, 1999.

Size-Class (mm)	Age Sample (X)	Age-groups in X 2	3	4	Length Sample (Y)	Calculated Age Representation in Y 2	3	4
70	2	2	0	0	3	3.0	0.0	0.0
75	2	2	0	0	7	7.0	0.0	0.0
80	7	6	1	0	15	12.9	2.1	0.0
85	12	12	0	0	26	26.0	0.0	0.0
90	28	26	2	0	46	42.7	3.3	0.0
95	49	45	4	0	106	97.3	8.7	0.0
100	85	57	28	0	160	107.3	52.7	0.0
105	87	53	34	0	170	103.6	66.4	0.0
110	93	41	52	0	149	65.7	83.3	0.0
115	53	18	35	0	105	35.7	69.3	0.0
120	32	12	19	1	56	21.0	33.3	1.8
125	23	7	14	2	45	13.7	27.4	3.9
130	6	0	5	1	21	0.0	17.5	3.5
135	9	0	8	1	18	0.0	16.0	2.0
140	3	0	2	1	7	0.0	4.7	2.3
145	4	0	4	0	6	0.0	6.0	0.0
150	1	0	0	1	1	0.0	0.0	1.0
155	0	0	0	0	0	0.0	0.0	0.0
160	0	0	0	0	0	0.0	0.0	0.0
165	0	0	0	0	0	0.0	0.0	0.0
170	0	0	0	0	0	0.0	0.0	0.0
175	0	0	0	0	0	0.0	0.0	0.0
180	0	0	0	0	1	0.0	0.0	1.0
Mean length					108.4	103.2	114.5	131.3
SD					12.6	10.3	11.2	6.6
Mean weight (g)					12.8	11.1	14.9	21.5
SD					4.3	3.2	4.4	3.7
Total samples	497	282	208	7	943	536	391	15
% contribution		56.7	41.9	1.4		56.8	41.4	1.6

Table 2. Coho smolt catch at Zolzap Creek enumeration fence, by week, in 1999.

Week ending	Catch
24-Apr	34
1-May	68
8-May	168
15-May	1,252
22-May	5,885
29-May	5,617
5-Jun	1,659
12-Jun	460
19-Jun	10
Total	15,153

Table 3. Non-coho catch at the spring juvenile and fall adult fences at Zolzap Creek, 1992-1999[a].

Species	Time/lifestage	1992	1993	1994	1995	1996	1997	1998	1999	Avg.
Pink	Fall Adult	115	149	251	52	72	44	23	71	97
Chum	Spring Juvenile						344	549	79	324
	Fall Adult	30	111	68	8	19	42	24	32	42
Sockeye	Spring Juvenile	4	244	328	189	119	0	798	231	239
	Fall Adult	4	11	28	7	0	39	10	11	14
Cutthroat	Spring Juvenile	12	69	36	67	121	42	268	141	95
	Spring Adult	308	278	224	43	55	2	117	30	132
	Fall Adult	17	27	14	28	18	12	14	28	20
Dolly Varden	Spring Juvenile	682	309	339	518	711	337	732	647	534
	Spring Adult	644	728	1529	28	44	7	25	5	376
	Fall Adult	9	21	10	81	39	21	30	174	48
Steelhead	Spring Juvenile	11	15	36	12	30	4	82	33	28
	Spring Adult	33	0	5	0	0	0	0	0	5
	Fall Adult	5	0	2	0	0	0	4	1	2
Lamprey[b]	Spring Juvenile	749	906	1277	2314	1333	1794	2264	1806	1555
	Spring Adult	-	-	-	-	28	97	144	199	117
	Fall Adult	-	-	-	2	16	4	1	0	5

[a] Trapping effort not equal between years.

[b] Adults and juveniles not distingushed for period 1992 - 1995.

Table 4. Coded-wire tag retention rates for Zolzap Creek coho smolts, 1999

Sampling Date	Tagging Date	Tag code	Hours held	Sample size	No. fish no tag	Percent retention
10-May	8-May	18-43-12	48	73	0	100
12-May	10-May	18-43-12	48	85	0	100
14-May	12-May	18-43-12	48	69	0	100
15-May	14-May	18-43-12	24	200	0	100
16-May	15-May	18-43-12	24	200	0	100
17-May	16-May	18-43-12	24	200	0	100
18-May	17-May	18-43-12	24	200	0	100
19-May	18-May	18-43-12	24	200	0	100
20-May	19-May	18-43-12	24	200	0	100
21-May	20-May	18-43-12	24	200	0	100
22-May	21-May	18-43-12	24	200	0	100
23-May	22-May	18-43-12	24	200	0	100
Subtotal				2,027	0	100.0
29-May	28-May	18-43-13	24	200	3	98.5
1-Jun	29-May	18-43-13	72	200	0	100
3-Jun	1-Jun	18-43-13	48	200	0	100
9-Jun	6-Jun	18-43-13	72	200	1	99.5
Total				800	4	99.5

Table 5. Coded-wire tagged coho smolt releases from Zolzap Creek, 1999.

Tag code	Tagging dates	No. AFC	Tag morts	No. released AFC	No. tagged [a]	No. AFC only [b]	No. released untagged [c]	Total release [d]	CWT mark rate [e]
18-43-12	8 May - 25 May	10,943	76	10,867	10,867	0	205	11,072	1.02
18-43-13	28 May - 9 June	3,754	30	3,724	3,705	19	28	3,752	1.01
	Total	14,697	106	14,591	14,572	19	233	14,824	1.02

[a] No. tagged (corrected for tag loss) = No. released AFC - (No. released AFC * No. lost tags / No. sampled); see Table 4.

[b] No. AFC only = No. released AFC - No. tagged

[c] No. released untagged = the number of unmarked fish released which belong to the same group as the tagged and AFC only fish.

[d] Total release = No. tagged + AFC only + untagged

[e] CWT mark rate = Total release / No. tagged

Table 6. Fence enumerations, carcass recoveries, and Petersen population estimates for adult coho escapement at Zolzap Creek, 1999.

Item	Adults	Total
Number live coho captured at fence	1,302	1,302
Number of live coho released untagged	11	11
Number live coho operculum tagged	1,221 [a]	1,221
Number coho carcasses recovered	186	186
Number of coho carcasses recovered untagged	23	23
Number of coho carcasses recovered tagged	163	163
Petersen estimate	1,393	1,393
Upper 95% CL	1,623	1,623
Lower 95% CL	1,196	1,196

[a] Adjusted for tag loss.

Table 7. Freshwater age distribution of adult coho at Zolzap Creek, 1999.

Sex	Age 2		Age 3		Total aged	Total unaged	Total sampled
	No.	%	No.	%			
Adult males	107	72.3	41	27.7	148	28	176
Adult females	70	64.8	38	35.2	108	18	126
Total adults	177	69.1	79	30.9	256	46	302

Table 8. Estimates of total escapement of adipose clipped coho and contribution to escapement at Zolzap Creek, 1993-1999.

Year	No. examined (A)	No. with adipose clips (B)	% AFC (C=B/Ax100)	Population estimate (D)	% sampled (E=A/Dx100)	Estimated adipose clips (F=B/AxD)	No. smolts [a] AFC	No. smolts [a] unclipped	No. smolts [a] % AFC	Contribution to escap.[b]	Smolt to spawner (%) [c]
1993	784	191	24.4	1,048	74.8	255	33,923	6,678	83.6	306	0.8
1994	2,416	499	20.7	2,536	95.3	524	22,986	3,348	87.3	600	2.3
1995	906	308	34.0	908	99.8	309	29,615	4,804	86.0	359	1.0
1996	1,030	218	21.2	1,039	99.1	220	10,166	2,203	82.2	268	2.2
1997	462	201	43.5	470	98.3	204	20,625	1,265	94.2	206	1.1
1998	963	212	22.0	967	99.6	213	13,566	992	93.2	228	1.6
1999	1,294	451	34.9	1,393	92.9	486	13,950	1,771	88.7	547	3.5
Avg.	1,122	297	29	1,194	94	316	20,690	3,009	88	359	1.8

[a] smolt releases of the previous migration year; an unknown number of additional unclipped releases were likely.

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

[c] % survival = estimated AFC + AFC below the fence / AFC smolts* 100.

Table 9. Estimated Canadian and American commercial and sport harvest of Zolzap Creek CWT coho in 1999 using tag recovery data (Mark Recovery Program, Fisheries and Oceans, Canada, and ADF&G mark tag and age lab, online searchable database).

Tag	Observed CWT catch [a]				Catch-sample ratio [b]			Estimated CWT catch [c]			
code	N. Troll	N. Net	Sport	Total	N. Troll	N. Net	Sport	N. Troll	N. Net	Sport	Total
Canadian											
28-16-21	0	3	1	4	0.0	1.0	5.6	0	3	6	9
Total	0	3	1	4	0.0	1.0	5.6	0	3	6	9
American											
28-16-21	122	31	5	158	2.9	2.8	6.5	354	87	32	473
Total	122	31	5	158	2.9	2.8	6.5	354	87	32	473
Total	122	34	6	162	2.9	3.8	12.0	354	90	38	482

Total commercial	444
Total sport	38
Total native fishery [d]	6
Total escapement [e]	492
Total CWT	980

[a] Observed CWT = CWT's recovered from the commercial and sport catch

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

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

[d] observed harvest

[e] Estimated CWT's (adipose clips corrected for tag loss at return) including those below the fence, and at the fishwheels; see Table 8

Table 10. Expanded Canadian and American commercial and sport harvest of Zolzap Creek coho and estimated total return, 1999.

Tag code	Total release	Smolts tagged [a]	Mark rate [b]	Expanded catch [c]								Grand Total	Contri-bution escap.	Total return [d]
				Canadian				American						
				Troll	Net	Sport	Total	Troll	Net	Sport	Total			
28-16-21	15,721	13,900	1.13	0	3	6	10	401	98	36	535	545		
Total 1 [e]	15,721	13,900	1.13	0	3	6	10	401	98	36	535	545	547	1,092
Total 2 [f]			2.87	0	9	16	25	1,017	249	93	1,358	1,383	1,393	2,776

[a] Number smolts released with tags (corrected for tag loss), Nass and Frith (1999).

[b] Mark rate at release (= No. released / No. marked) for smolts and Total 1 (MRP method), and mark rate at return for total 2 (Escapement method).

[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 (Table 9).

[f] Total 2 expanded catch is calculated using the total adipose clip rate at recovery and the total estimated catch for all tag codes (Table 9).

Table 11. Estimated commercial harvest distribution of Zolzap Creek CWT coho by area and gear type, 1999. Percentage is of total commercial harvest (does not include sport recoveries).

Area [a]	Net	%	Troll	%	Total	%
Canada						
Areas 1-5	3	0.7	0	0.0	3	0.7
subtotal	3	0.7	0	0.0	3	0.7
U.S.A. (Alaska)						
Northern Outside	0	0.0	27	6.2	27	6.2
Central Outside	0	0.0	156	35.1	156	35.1
Southern Outside	21	4.8	46	10.4	67	15.1
Southern Inside	47	10.6	81	18.3	128	28.8
Central Inside	19	4.2	0	0.0	19	4.2
Southern Intermediate	0	0.0	36	8.2	36	8.2
Central Intermediate	0	0.0	8	1.8	8	1.8
subtotal	87	19.5	355	79.8	442	99.3
TOTAL	90	20.2	355	79.8	445	100.0

[a] includes respective sub-areas

Table 12. Adult and juvenile coho enumeration and age composition, and exploitation and survival at Zolzap Creek, 1992-1999.

Migration	Smolt Out-migration						Adult Escapement					Can		US		Total	Total
Year	Count	Estimate	CWT	% Age2	% Age3	% Age4	Count	Estimate	Return	% Age2	% Age3	%Exp.	% Cat.	%Exp.	% Cat.	%Exp.	%Surv.
1992	40,601	53,000	33,150	54.3	45.7	0.0	691	1,561	-	79.0	21.0	-	-	-	-	-	-
1993	26,334	51,000	22,649	67.9	32.1	0.0	794	1,048	2,832	58.3	41.7	15.5	24.6	47.5	75.4	63.0	2.1
1994	34,419	41,000	29,319	29.8	69.5	0.7	2,438	2,536	9,645	60.4	39.6	18.6	25.7	53.7	74.3	72.3	8.9
1995	12,369	13,000	10,156	55.1	37.9	7.0	908	908	3,057	41.3	58.7	12.9	19.0	54.8	81.0	67.7	3.6
1996	20,745	23,000	20,519	72.2	27.1	0.7	1,039	1,039	3,159	53.2	46.8	21.4	35.3	39.2	64.7	60.5	6.6
1997	15,099	18,000	13,566	65.1	34.9	0.0	470	470	1,072	70.8	29.2	8.8	16.2	45.4	83.8	54.2	2.4
1998	15,937	19,000	13,900	58.3	40.5	1.2	967	967	1,986	32.1	67.9	0.0	0.0	46.0	100.0	46.0	2.9
1999	15,153	16,000	14,572	56.8	41.5	1.6	1,302	1,393	2,808	69.1	30.9	1.2	3.1	48.3	96.9	49.5	7.0
Average	22,582	29,250	19,729	57.4	41.2	1.4	1,076	1,240	3,508	58.0	42.0	11.2	17.7	47.8	82.3	59.0	4.8

Table 13. Adult and juvenile coho production and age composition by brood year, Zolzap Creek, 1990-1997[a].

CWT's

Brood	Smolt Production				Adult Returns			Smolts			Adults		% Total Survival			
Year	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	Age 2	Age 3	Age 4	Total
1990	18,000	7,270	205	25,476	402	802	1,204	70.7	28.5	0.8	33.4	66.6	2.2	11.0	0.0	4.7
1991	15,379	20,377	711	36,466	1,223	628	1,851	42.2	55.9	1.9	66.1	33.9	8.0	3.1	0.0	5.1
1992	8,737	3,849	144	12,730	441	315	757	68.6	30.2	1.1	58.3	41.7	5.1	8.2	0.0	5.9
1993	5,596	5,561	0	11,157	359	136	495	50.2	49.8	0.0	72.5	27.5	6.4	2.4	-	4.4
1994	14,815	4,735	167	19,716	330	297	627	75.1	24.0	0.8	52.7	47.3	2.2	6.3	0.0	3.2
1995	8,831	5,630	239	14,700	140	303	443	60.1	38.3	1.6	31.7	68.3	1.6	5.4	0.0	3.0
1996	8,104	6,048	-	14,151	677	-	677	57.3	42.7	-	-	-	8.4	-	-	4.8
1997	8,280	-	-	8,280	-	-	0	100.0	-	-	-	-	-	-	-	0.0
Avg.[b]	11,893	7,903	244	20,041	483	413	896	61.1	37.8	1.1	52.4	47.6	4.2	6.1	0.0	4.4

All fish

Brood	Smolt Production				Adult Returns			Smolts			Adults		% Total Survival			
Year	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	Age 2	Age 3	Age 4	Total
1990	28,779	16,371	287	45,437	1,651	3,819	5,470	63.3	36.0	0.6	30.2	69.8	5.7	23.3	0.0	12.0
1991	34,629	28,495	910	64,034	5,826	1,794	7,620	54.1	44.5	1.4	76.5	23.5	16.8	6.3	0.0	11.9
1992	12,218	4,927	161	17,306	1,263	1,478	2,741	70.6	28.5	0.9	46.1	53.9	10.3	30.0	0.0	15.8
1993	7,163	6,233	0	13,396	1,681	313	1,994	53.5	46.5	0.0	84.3	15.7	23.5	5.0	0.0	14.9
1994	16,606	6,282	228	23,116	759	1,348	2,107	71.8	27.2	1.0	36.0	64.0	4.6	21.5	0.0	9.1
1995	11,718	7,695	263	19,676	638	868	1,505	59.6	39.1	1.3	42.4	57.6	5.4	11.3	0.0	7.6
1996	11,077	6,640	-	17,717	1,940	-	1,940	62.5	37.5	-	-	-	17.5	-	-	10.9
1997	9,091	-	-	9,091	-	-	0	100.0	-	-	-	-	-	-	-	0.0
Avg.[b]	18,519	11,667	308	30,494	1,969	1,604	3,573	62.1	37.0	0.9	52.6	47.4	11.1	16.2	0.0	11.9

[a] (-) Incomplete data for 1996 and 1997, to be completed with data from subsequent returns.

[b] average for "Total" includes years for which complete production data is available.

FIGURES

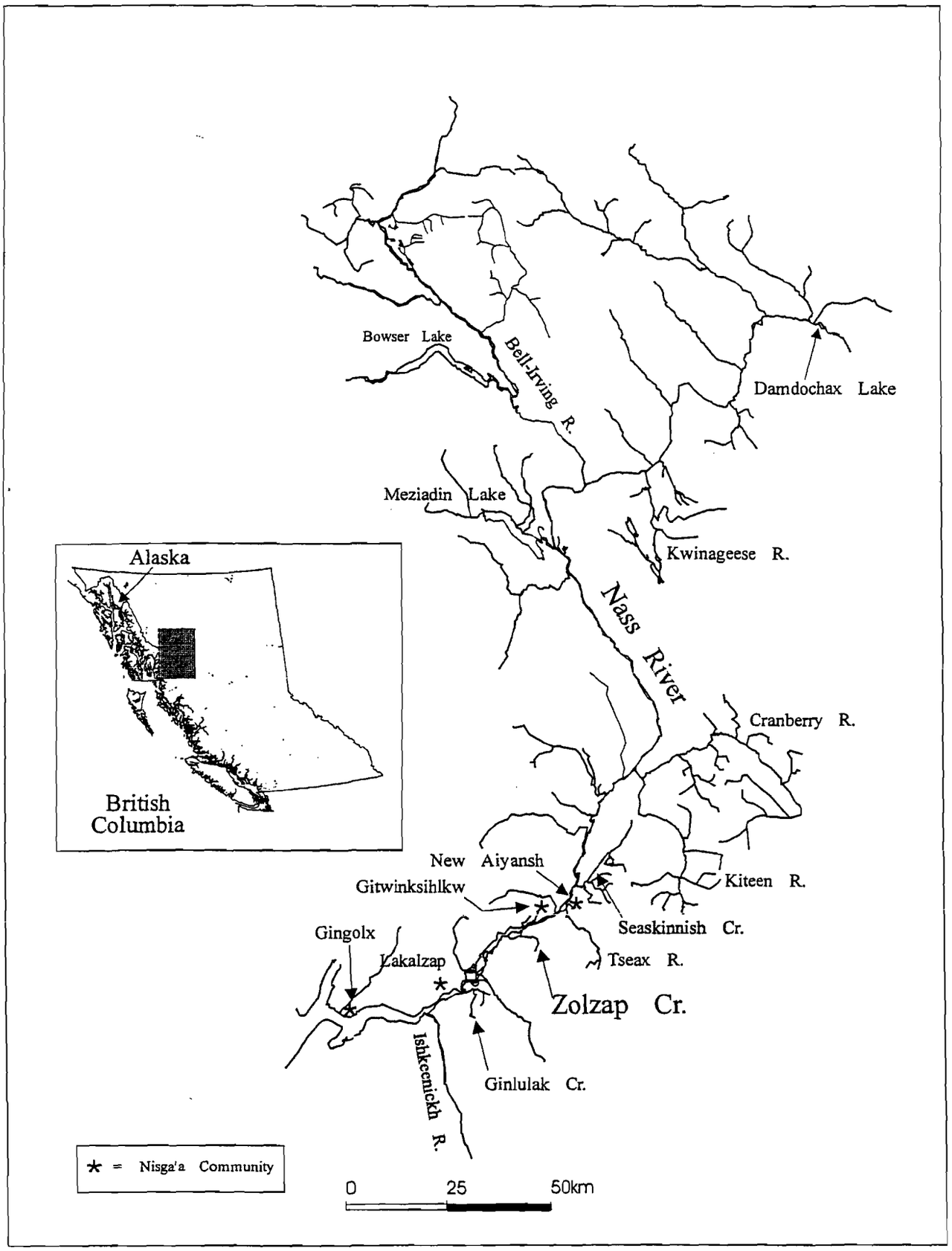

Figure 1. The Nass River watershed, British Columbia.

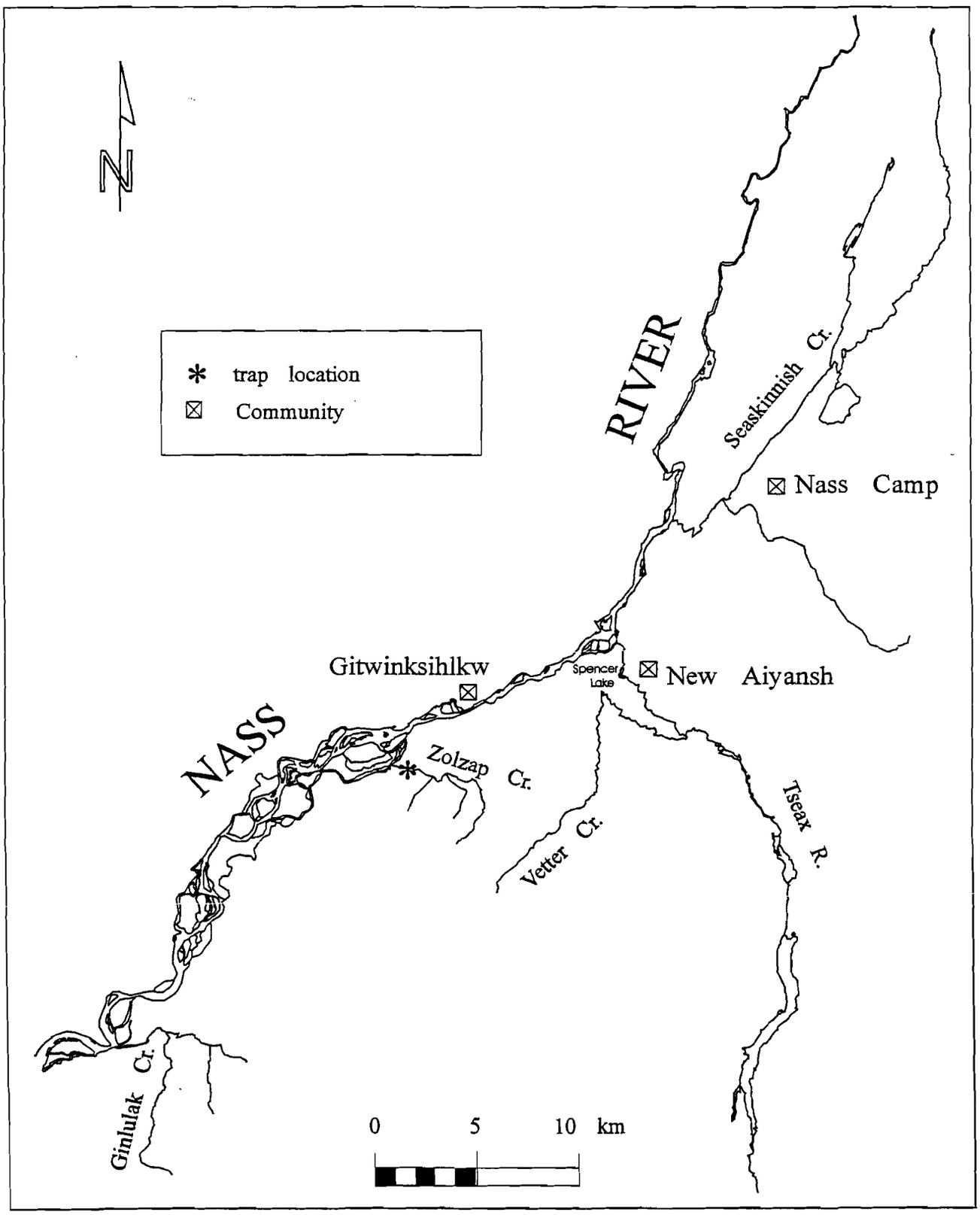

Figure 2. Zolzap Creek and location of enumeration fence.

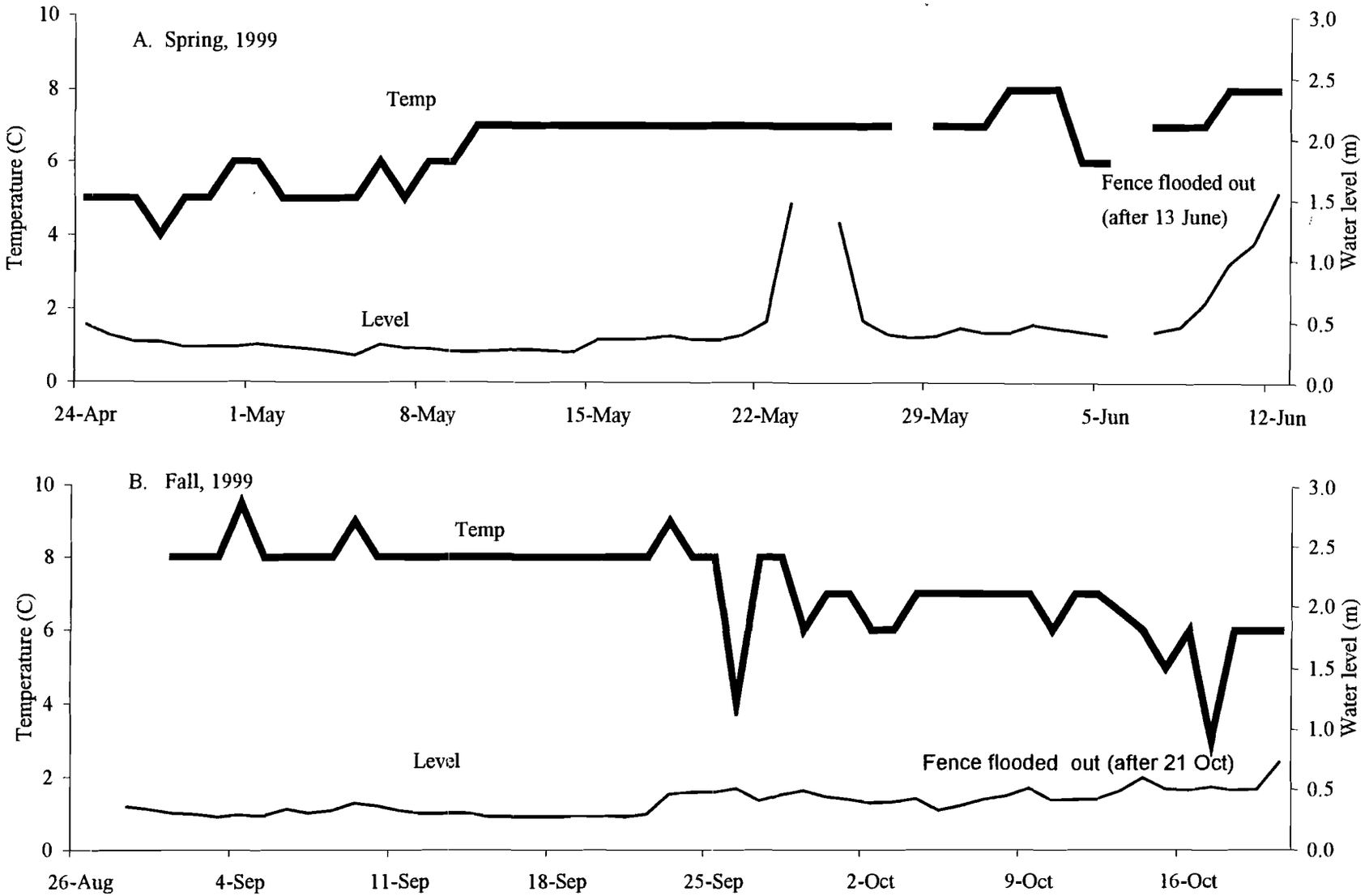

Figure 3. Water level and temperature at Zolzap Creek, 1999.

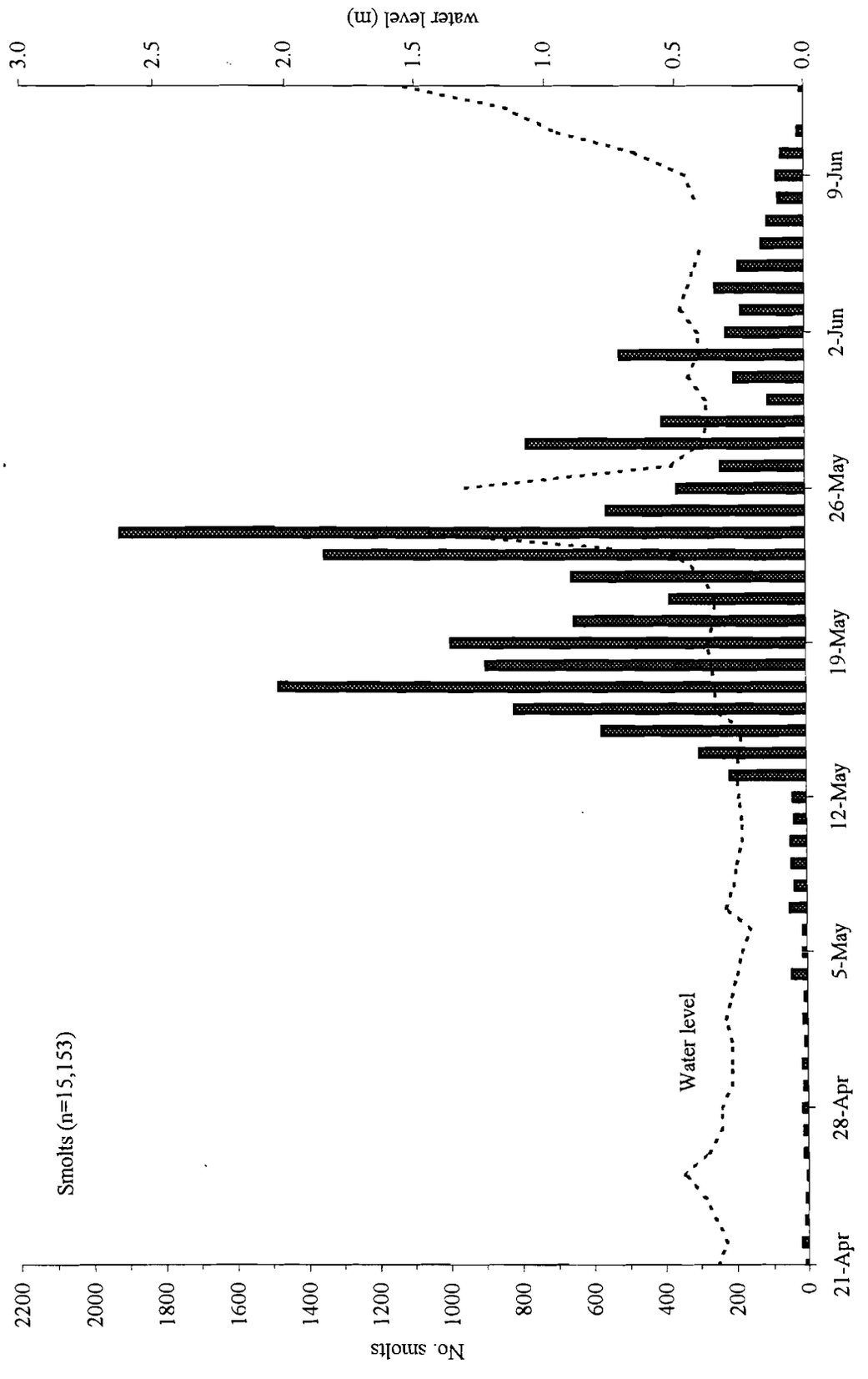

Figure 4. Daily migration of coho smolts at Zolzap Creek, 21 April - 13 June, 1999.

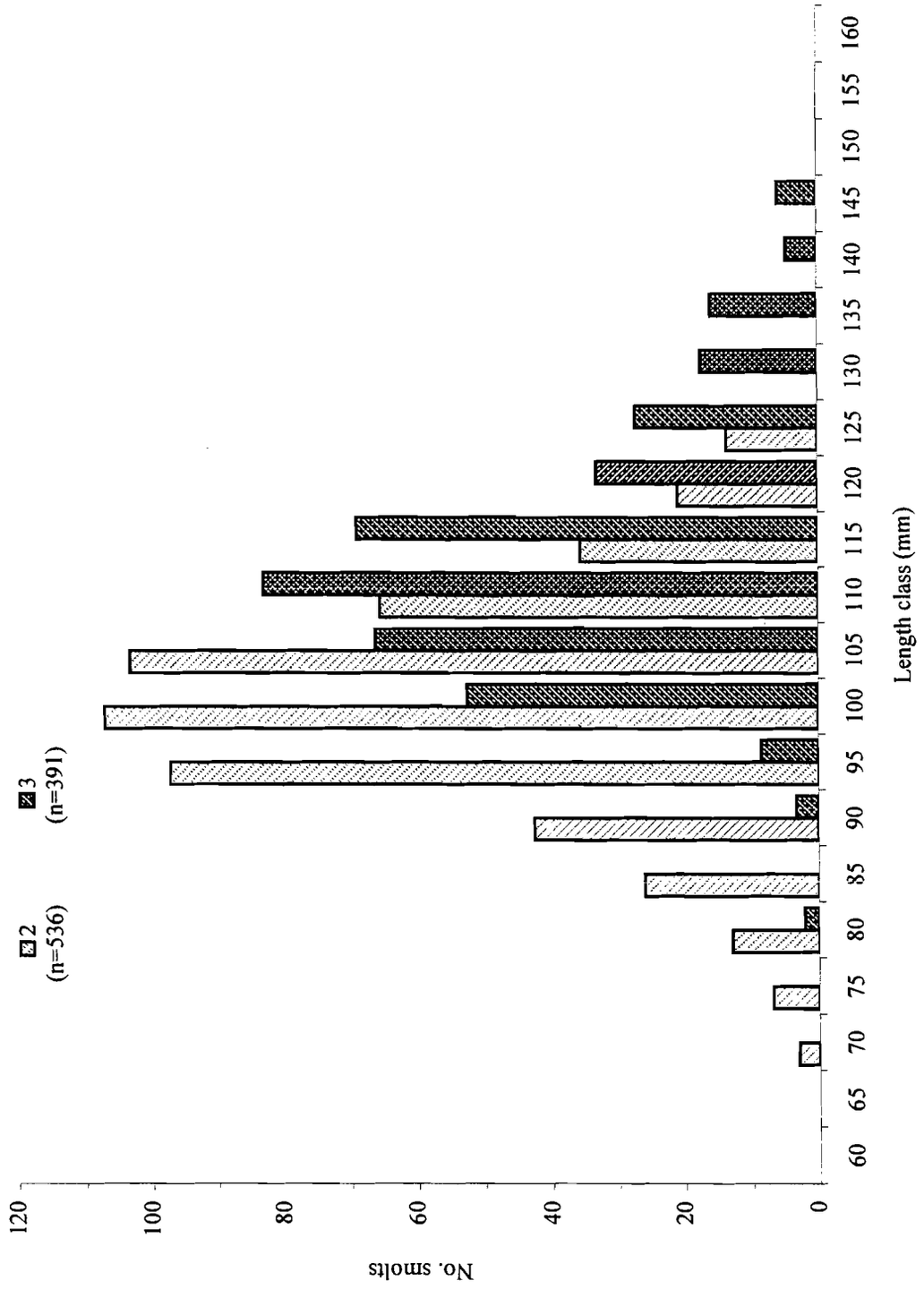

Figure 5. Length-frequency and calculated age distribution of Zolzap Creek coho smolts, 1999. Age 4 samples are excluded due to low sample sizes.

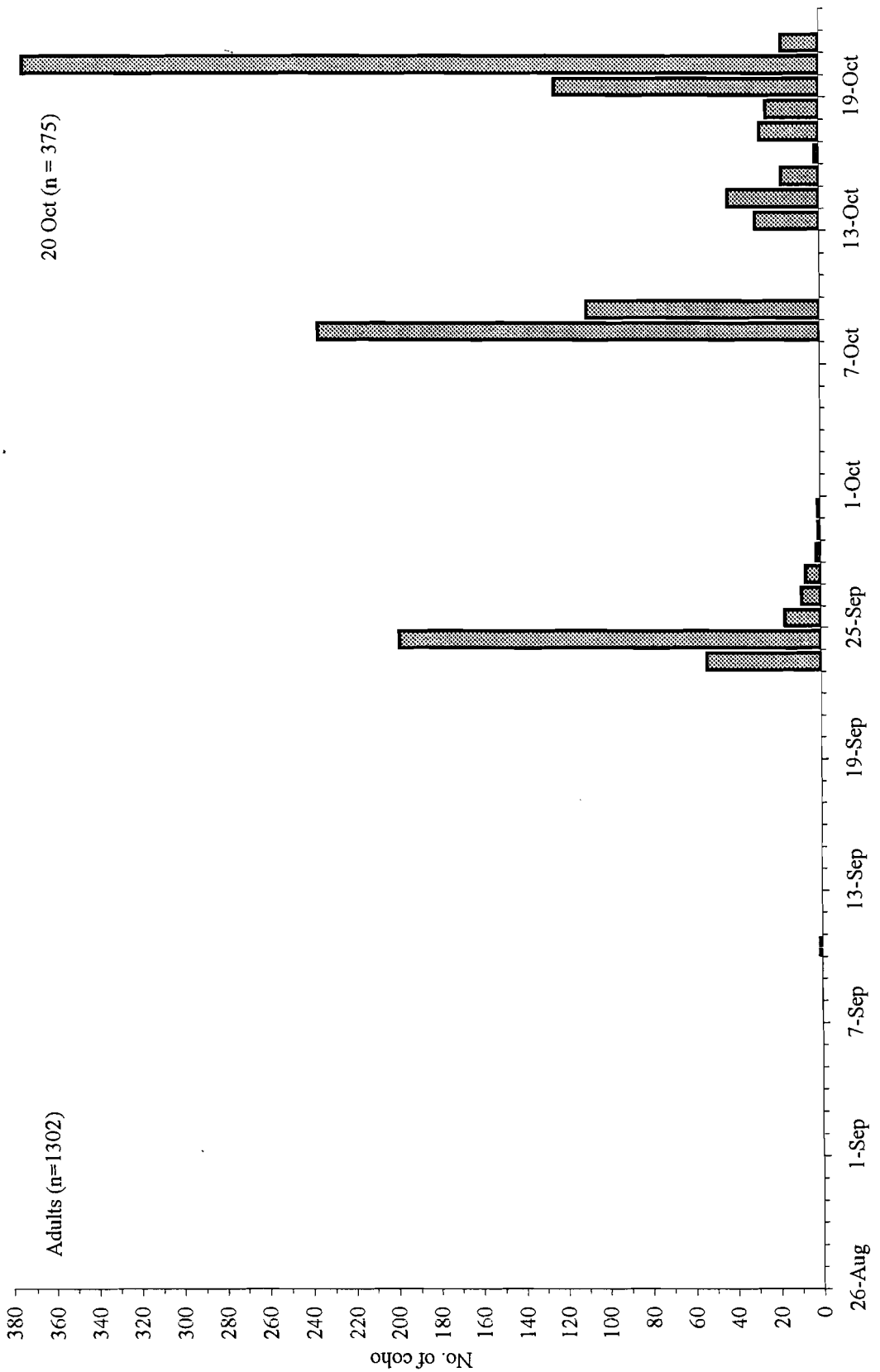

Figure 6. Daily counts of adult coho at the Zolzap Creek enumeration fence, 26 Aug - 21 Oct, 1999.

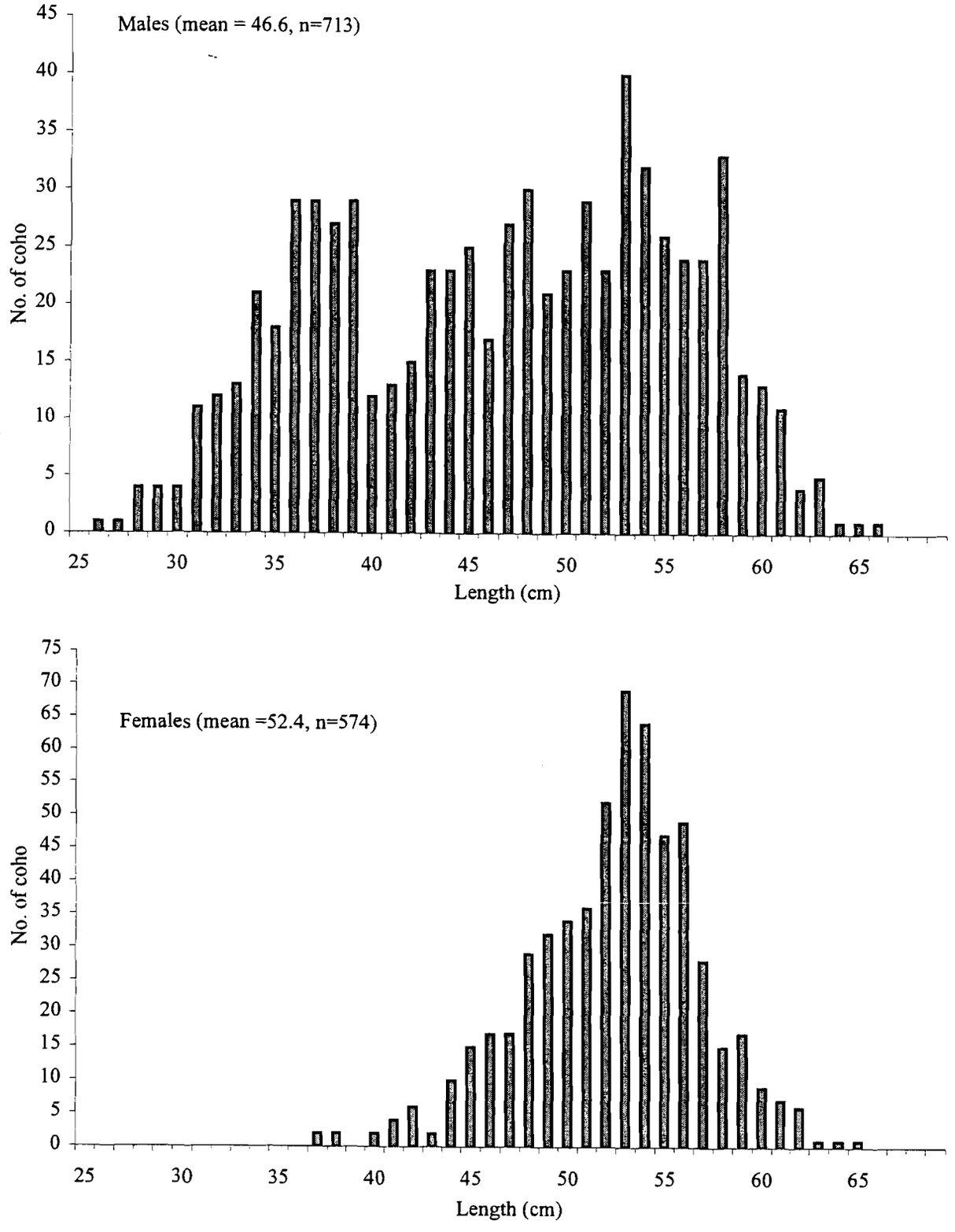

Figure 7. Length-frequency distribution of coho, by sex, Zolzap Creek, 1999.

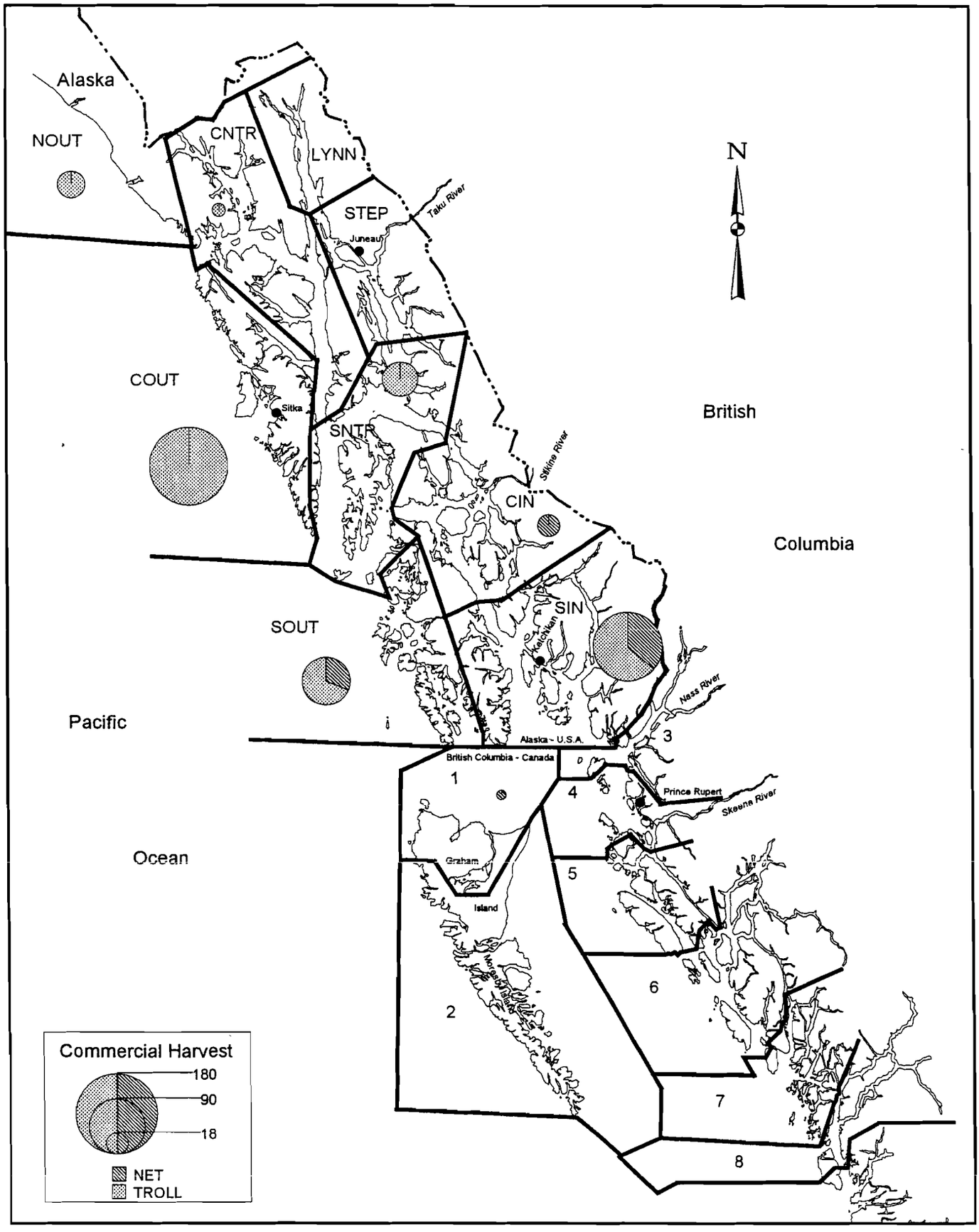

Figure 8. Fisheries Statistical Areas for the north coast of British Columbia and southeast Alaska, and commerical harvest distribution of Zolzap Creek CWT coho, 1999.

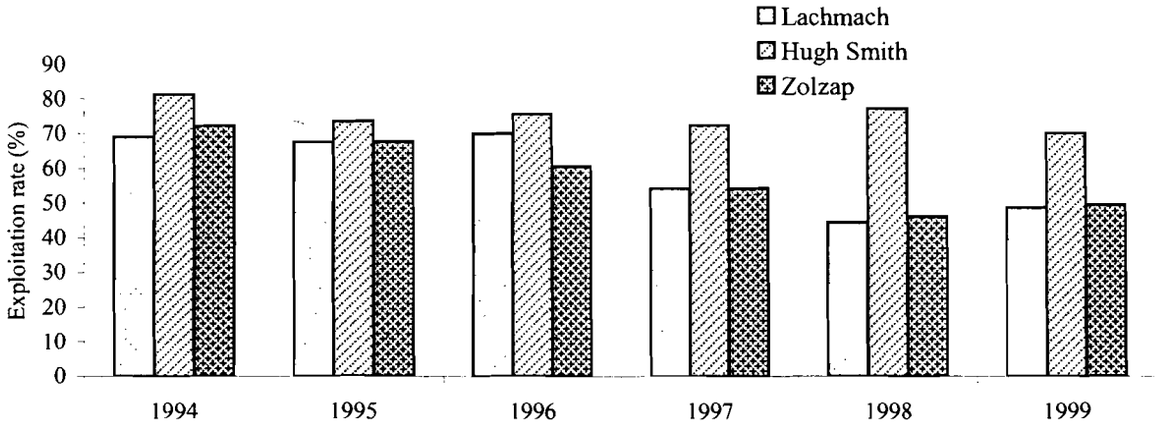

Figure 9. Exploitation rates for three wild coho indicator stocks.

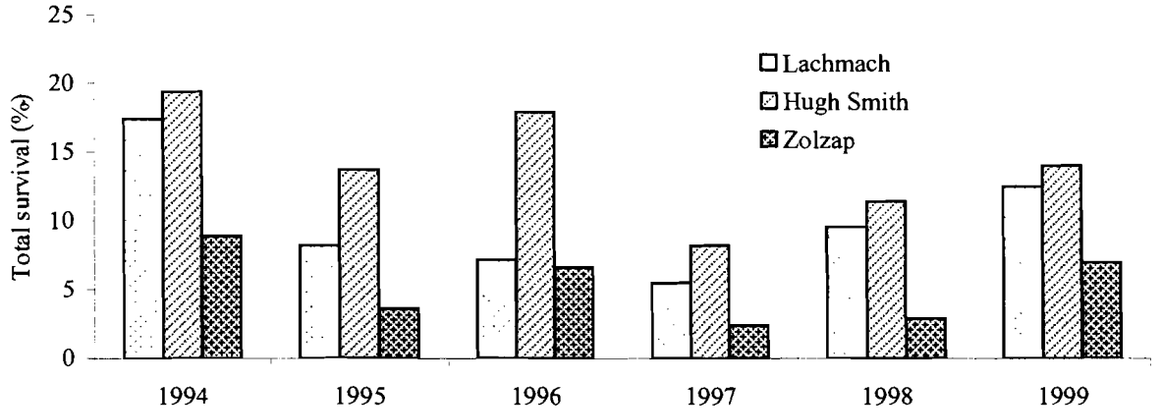

Figure 10. Total percent survivals for three wild coho indicator stocks.

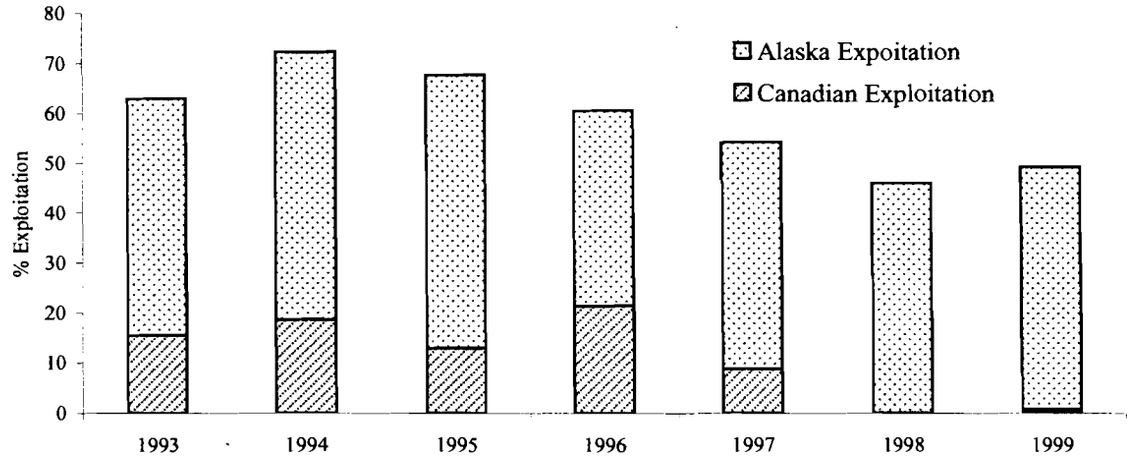

Figure 11. Canadian and Alaskan expoitation rates on Zolzap Creek coho, 1993-1999.

APPENDICES

Table A-1. Juvenile coho catch at Zolzap Creek enumeration fence, 1999.

Date	fry/presmolts	smolts	morts
21-Apr	5	6	0
22-Apr	0	16	0
23-Apr	0	8	0
24-Apr	0	4	0
25-Apr	3	2	0
26-Apr	2	11	0
27-Apr	6	11	0
28-Apr	0	13	0
29-Apr	0	10	0
30-Apr	10	14	0
1-May	1	7	0
2-May	0	12	0
3-May	1	7	0
4-May	0	44	0
5-May	0	12	0
6-May	0	10	0
7-May	0	49	0
8-May	2	34	0
9-May	2	43	0
10-May	2	46	0
11-May	2	35	0
12-May	3	38	0
13-May	1	215	3
14-May	1	301	0
15-May	1	574	1
16-May	3	818	0
17-May	4	1,484	1
18-May	8	898	0
19-May	21	997	0
20-May	4	650	0
21-May	6	382	0
22-May	0	656	0
23-May	0	1,353	0
24-May	96	1,922	0
25-May	210	560	0
26-May	193	361	0
27-May	359	237	21
28-May	155	783	3
29-May	182	401	0
30-May	50	104	0
31-May	47	199	1
1-Jun	50	520	3
2-Jun	17	220	3
3-Jun	19	180	14
4-Jun	33	251	0

Table A-1. Juvenile coho catch at Zolzap Creek enumeration fence, 1999.

Date	fry/presmolts	smolts	morts
5-Jun	67	185	3
6-Jun	28	120	0
7-Jun	110	106	2
8-Jun	14	73	4
9-Jun	16	79	0
10-Jun	40	65	0
11-Jun	45	17	0
12-Jun	0	0	0
13-Jun	38	10	0
Total	1,857	15,153	59

Table B-1. Non-coho catch at Zolzap Creek enumeration fence, 1999.

	Steelhead		Cutthroat		D. Varden		Sockeye	Chum			
Date	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Juvenile	Cottid	Lamprey	Stickleback
21-Apr	2	0	3	0	11	0	0	0	1	90	0
22-Apr	1	0	1	1	9	0	0	8	4	132	4
23-Apr	0	0	1	0	11	0	0	2	2	73	7
24-Apr	1	0	0	0	6	0	0	1	2	125	0
25-Apr	0	0	6	0	5	2	0	0	5	133	4
26-Apr	0	0	1	0	4	0	0	2	4	93	10
27-Apr	0	0	0	0	8	0	0	3	6	114	6
28-Apr	1	0	4	3	5	0	0	7	5	43	5
29-Apr	3	0	0	2	11	0	0	4	4	15	3
30-Apr	2	0	0	3	8	0	0	0	4	64	8
1-May	0	0	0	1	7	0	0	4	2	12	2
2-May	0	0	1	1	2	0	0	9	3	18	5
3-May	0	0	0	0	1	0	1	16	5	83	4
4-May	0	0	1	2	30	2	0	5	10	52	7
5-May	0	0	0	0	5	0	10	0	3	78	1
6-May	0	0	0	2	15	0	0	0	2	30	2
7-May	0	0	1	0	13	0	5	0	3	22	1
8-May	1	0	4	1	10	0	7	0	2	32	2
9-May	0	0	0	0	5	0	4	0	1	45	7
10-May	1	0	1	2	23	0	6	0	0	21	4
11-May	3	0	1	1	7	0	5	1	2	11	2
12-May	1	0	1	2	15	1	10	0	1	15	0
13-May	0	0	9	0	17	0	2	1	1	20	2
14-May	1	0	10	0	26	0	6	0	1	22	2
15-May	2	0	16	4	27	0	5	0	1	26	1
16-May	0	0	9	0	51	0	13	0	5	17	1
17-May	0	0	4	1	23	0	13	0	0	17	3
18-May	0	0	1	0	19	0	11	0	0	22	2
19-May	1	0	8	1	18	0	7	0	4	21	4
20-May	0	0	1	0	17	0	15	0	4	60	4

Table B-1. Non-coho catch at Zolzap Creek enumeration fence, 1999.

Date	Steelhead		Cutthroat		D. Varden		Sockeye	Chum			
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Juvenile	Cottid	Lamprey	Stickleback
21-May	0	0	4	0	31	0	7	0	0	30	3
22-May	0	0	3	0	6	0	4	0	1	25	1
23-May	1	0	7	0	13	0	10	0	1	9	3
24-May	0	0	1	0	2	0	7	0	0	1	0
25-May	0	0	0	0	0	0	0	0	1	0	0
26-May	0	0	0	0	2	0	4	0	0	2	0
27-May	0	0	0	0	17	0	0	0	2	2	0
28-May	2	0	6	0	14	0	16	5	2	24	4
29-May	4	0	7	0	25	0	15	0	3	174	4
30-May	0	0	4	0	14	0	24	5	3	25	1
31-May	5	0	4	2	37	0	3	1	0	41	0
1-Jun	0	0	4	0	10	0	4	1	2	22	3
2-Jun	0	0	0	0	21	0	1	1	1	21	1
3-Jun	0	0	2	1	12	0	1	0	3	30	2
4-Jun	0	0	1	0	2	0	0	0	1	17	1
5-Jun	0	0	2	0	0	0	5	1	1	7	0
6-Jun	0	0	0	0	10	0	1	1	4	14	0
7-Jun	0	0	0	0	9	0	4	0	1	13	1
8-Jun	1	0	0	0	12	0	0	0	0	30	0
9-Jun	0	0	1	0	0	0	1	0	1	6	0
10-Jun	0	0	0	0	0	0	3	1	0	2	1
11-Jun	0	0	0	0	0	0	0	0	5	0	0
12-Jun	0	0	0	0	0	0	0	0	0	0	0
13-Jun	0	0	11	0	1	0	1	0	0	4	1
Total	33	0	141	30	647	5	231	79	119	2,005	129

Table C-1. Coded-wire tagging data for coho smolts at Zolzap Creek, 1999.

Date	Total smolts	Fence morts	Tag code	No. AFC	Tag morts	No. rlsd. untagged	No. rlsd. AFC
21-Apr	6	0	0	0	0	6	0
22-Apr	16	0	0	0	0	16	0
23-Apr	8	1	0	0	0	7	0
24-Apr	4	0	0	0	0	4	0
25-Apr	2	0	0	0	0	2	0
26-Apr	11	0	0	0	0	11	0
27-Apr	11	2	0	0	0	9	0
28-Apr	13	1	0	0	0	12	0
29-Apr	10	2	0	0	0	8	0
30-Apr	14	2	0	0	0	12	0
1-May	7	0	0	0	0	7	0
2-May	12	0	0	0	0	12	0
3-May	7	0	0	0	0	7	0
4-May	44	0	0	0	0	44	0
5-May	12	1	0	0	0	0	0
6-May	10	0	0	0	0	0	0
7-May	49	0	0	0	0	0	0
8-May	34	0	18-43-12	83	10	0	73
9-May	43	0	0	0	0	0	0
10-May	46	0	18-43-12	89	4	0	85
11-May	35	0	0	0	0	0	0
12-May	38	1	18-43-12	72	3	0	69
13-May	215	0	0	0	0	0	0
14-May	301	0	18-43-12	509	5	6	504
15-May	574	1	18-43-12	572	3	0	569
16-May	818	0	18-43-12	817	6	1	811
17-May	1,484	0	18-43-12	1,482	8	2	1,474
18-May	898	0	18-43-12	897	5	0	892
19-May	997	0	18-43-12	992	6	5	986
20-May	650	0	18-43-12	649	5	1	644
21-May	382	1	18-43-12	379	4	2	375
22-May	656	0	18-43-12	652	5	4	647
23-May	1,353	3	18-43-12	1,345	5	5	1,340
24-May	1,922	65	18-43-12	1,845	5	12	1,840
25-May	560	0	18-43-12	560	2	0	558
26-May	361	0	0	0	0	0	0
27-May	237	5	0	0	0	10	0
28-May	783	4	18-43-13	1,352	15	7	1,337
29-May	401	2	18-43-13	396	4	1	392
30-May	104	0	0	0	0	0	0
31-May	199	1	0	0	0	0	0
1-Jun	520	3	18-43-13	811	4	7	807
2-Jun	220	1	0	0	0	0	0
3-Jun	180	0	18-43-13	395	3	2	392

Table C-1. Coded-wire tagging data for coho smolts at Zolzap Creek, 1999.

Date	Total smolts	Fence morts	Tag code	No. AFC	Tag morts	No. rlsd. untagged	No. rlsd. AFC
4-Jun	251	0	0	0	0	0	0
5-Jun	185	0	0	0	0	0	0
6-Jun	120	0	18-43-13	548	2	6	546
7-Jun	106	0	0	0	0	0	0
8-Jun	73	0	0	0	0	0	0
9-Jun	79	0	18-43-13	252	2	5	250
10-Jun	65	0	0	0	0	0	0
11-Jun	17	0	0	0	0	0	0
12-Jun	0	0	0	0	0	0	0
13-Jun	10	0	0	0	0	0	0
Total	15,153	96	-	14,697	106	233	14,591

Table D-1. Daily counts of adult coho at Zolzap Creek enumeration fence, 1999.

Date	No. examined	No. operculum tagged
10-Sep	1	1
11-Sep	0	0
12-Sep	0	0
13-Sep	0	0
14-Sep	0	0
15-Sep	0	0
16-Sep	0	0
17-Sep	0	0
18-Sep	0	0
19-Sep	0	0
20-Sep	0	0
21-Sep	0	0
22-Sep	0	0
23-Sep	54	53
24-Sep	199	198
25-Sep	17	16
26-Sep	9	9
27-Sep	7	7
28-Sep	2	2
29-Sep	1	1
30-Sep	1	1
1-Oct	0	0
2-Oct	0	0
3-Oct	0	0
4-Oct	0	0
5-Oct	0	0
6-Oct	0	0
7-Oct	0	0
8-Oct	237	235
9-Oct	110	109
10-Oct	0	0
11-Oct	0	0
12-Oct	0	0
13-Oct	30	30
14-Oct	43	43
15-Oct	18	17
16-Oct	2	2
17-Oct	28	28
18-Oct	25	25
19-Oct	125	123
20-Oct	375	374
21-Oct	18	18
Totals	1,302	1,292