Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2499

2001

ENUMERATION OF ADULT CHUM SALMON, *Oncorhynchus keta*, IN THE FISHING BRANCH RIVER, YUKON TERRITORY, 1998

by

I. Boyce and B. Wilson

Fisheries and Oceans Canada

Science Branch, Pacific Region

100 – 419 Range Road

Whitehorse, Yukon

Y1A 3V1

Cat. No. Fs 97-4/2499E ISSN 0706-6473

Correct citation for this publication:

Boyce, I. and B. Wilson. 2001. Enumeration of adult chum salmon, *Oncorhynchus keta*, in the Fishing Branch River, Yukon Territory, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2499: 25 p.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Boyce, I. and B. Wilson. 2001. Enumeration of adult chum salmon, *Oncorhynchus keta*, in the Fishing Branch River, Yukon Territory, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2499: 25 p.

A total of 13,564 migrating adult chum salmon, *Oncorhynchus keta,* was enumerated at a weir on the Fishing Branch River from 31 August to 22 October 1998. The run was estimated to be 60% female (n=13,564) and 77.4% age 4_1, 22.1% age 5_1, and 0.4% age 6_1 (n=730). Fork length (mm) averaged 671 for males and 628 for females (n=750). A sample of 29 carcasses obtained at the weir was 65.5% age 4_1, 31.0% age 5_1, 3.4% age 6_1, and 72% female. Milt/egg retention averaged 25% for male and 20% for female carcasses (st. dev. for each = 33%). Six grey and 189 orange spaghetti tags were observed; 46% of these, and four radio tags, were recovered. Spaghetti tag loss was identified on four of 10,440 fish examined. Seventy-four juvenile coho salmon were captured for DNA sampling. Water temperatures ranged from 7°C to 1.5°C; level fluctuated by 0.4 m. Air temperatures ranged from 21°C to -21°C.

RÉSUMÉ

Boyce, I. and B. Wilson. 2001. Enumeration of adult chum salmon, *Oncorhynchus keta*, in the Fishing Branch River, Yukon Territory, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2499: 25 p.

On a dénombré 13 564 saumons kétas, *Oncorhynchus keta,* adultes en migration à une barrière de dénombrement sur la rivière Fishing Branch entre le 31 août et le 22 octobre 1998. On a estimé que la remonte était composée à 60 % de femelles (n=13 564), et que les proportions des poissons d'âge 4_1, 5_1 et 6_1 étaient respectivement de 77,4 %, 22,1 % et 0,4 % (n=730). La longueur à la fourche moyenne était de 671 mm chez les mâles et de 628 mm chez les femelles (n=750). Un échantillon de 29 carcasses prélevé à la barrière était composé à 65,5 % de saumons d'âge 4_1, à 31,0 % saumons d'âge 5_1 et à 3,4 % de saumons d'âge 6_1, et renfermait 72 % de femelles. La rétention de laitance ou d'oeufs chez les carcasses était en moyenne de 25 % (mâles) et de 20 % (femelles) (écart-type de 33 % dans les deux cas). On a observé 6 marques spaghettis grises et 189 orange; 46 % de ces marques et quatre radiomarques ont été récupérées. On a relevé une perte de marque spaghetti chez quatre des 10 440 poissons examinés. On a capturé 74 saumons cohos juvéniles à des fins d'échantillonnage d'ADN. Les températures de l'eau ont varié de 7 °C à 1,5 °C, et le niveau de l'eau a fluctué de 0,4 m. Les températures de l'air ont varié de 21 °C à -21 °C.

INTRODUCTION

Chum salmon, *O. keta*, native to the south fork of the Fishing Branch River, have been enumerated by means of a weir from 1972 to 1975, 1985 to 1989, and 1991 to 1998. Field operations and administration have been conducted by Fisheries and Oceans Canada (DFO) with the involvement in most years of the Vuntut Gwitchin First Nation (VGFN).

The data collected at the Fishing Branch River weir is part of an ongoing program to enumerate the chum salmon returning each fall to spawn via the Yukon River and Porcupine River systems. The south fork of the Fishing Branch River is considered an important spawning area for chum salmon migrating up the Porcupine River.

Normally the weir at the Fishing Branch River is not operational until late August. However, in 1998 it was installed in July in order to determine the number of chinook salmon migrating in to the south fork of the Fishing Branch River (Doehle, 1999). The weir program was divided into two components administratively: prior to 25 August 1998, the VGFN administered the project, whereas post-24 August, DFO administered the project. Staffing at the weir site was different for each component of the program. The July to late August period was funded through the Canada/United States Yukon River Panel Restoration & Enhancement (R&E) Fund. VGFN project details are documented in a separate report to the Yukon River Panel (Doehle 1999).

BACKGROUND AND OBJECTIVES

The 1998 Fishing Branch River weir project supported the Upper Yukon River Fall chum Salmon Radio Telemetry and Mark-Recapture Project (JTC November 1998). This is an ongoing co-operative project involving the U.S. National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), the Alaska Department of Fish and Game (ADF&G) and DFO. The primary objective of the project is to study the distribution of fall chum salmon stocks throughout the upper Yukon River drainage basin.

Associated with the telemetry study was a network of remote satellite-linked tracking stations. In 1998, in addition to several others throughout the Yukon River drainage basin upstream of Rampart, remote tracking stations were in place at the Canada/U.S. border on the Porcupine River, and approximately 150m downstream from the Fishing Branch River weir. In 1998, several hundred fall chum salmon were tagged with radio transmitters at Rampart by the U.S. NMFS. Some of these fish were also marked with gray spaghetti tags.

USFWS crews at Rampart tagged several thousand fall chum salmon with orange spaghetti tags. Results from 1997 had identified a decrease in the ratio of tagged to not-tagged fish as distance from the tagging site increased. In order to test if this was caused by tag loss, the left pelvic fin was clipped on all spaghetti-tagged fish in 1998.

The objectives of the 1998 Fishing Branch River chum salmon enumeration project were to:

- enumerate by species and sex, all salmon that passed through the weir;
- sample 750 live chum salmon for fork length, scales (five per fish), gender, and the presence or absence of external marks, spaghetti tags, and radio transmitters;
- sample 150 dead (post-spawn) salmon for post-orbital hypural (POH) length, gender, age (based on scales, pectoral fins and vertebrae) and egg/milt retention;
- examine all fish for tags, including spaghetti tags and radio tags, and to record tag identification numbers and condition for any tagged fish captured;
- dip-net 1,000 fish per week to identify presence or absence of pelvic fin-clip, in order to assess rates of spaghetti tag loss;
- identify tagging needle marks on any fish possessing a left pelvic fin-clip but lacking a spaghetti tag;
- record air temperature and Fishing Branch River water level and water temperature at four hour intervals; and to
- collect DNA samples from 200 juvenile coho salmon and any adult coho salmon captured.

WATERSHED DESCRIPTION

Located in the northern Yukon Territory, the south fork of the Fishing Branch River is a headwater tributary of the Porcupine River, a major tributary to the Yukon River (Figure 1). The Fishing Branch River flows northeast out of the Ogilvie Mountains, draining an area of approximately 1700 square kilometres (NTS 116 J.K E 1/2, Department of Mines and Technical Surveys, 1959). The south fork joins the north fork near Bear Cave Mountain and flows into the Miner River, a tributary of the upper Porcupine River. The spawning area on the Fishing Branch River is approximately 2,600 km from the Bering Sea (Bergstrom 1992).

The terrain in the Fishing Branch River watershed includes rolling hills with elevations below 450 m and some mountains as high as 1000 m. Muskeg often extends to the riverbank. Tree species include black and white spruce, willow, larch and birch. There are ponds and thermokarst basins in the region, but no lakes (Oswald and Senyk 1977).

The closest climatological station to the Fishing Branch River is located in Old Crow, which is approximately 120 km north of the weir site. Temperatures recorded at the station during the 1968-1990 period averaged -9.3 °C and ranged from –59 °C to 32 °C. The mean annual precipitation during this period was 239.5 mm (Environment Canada files).

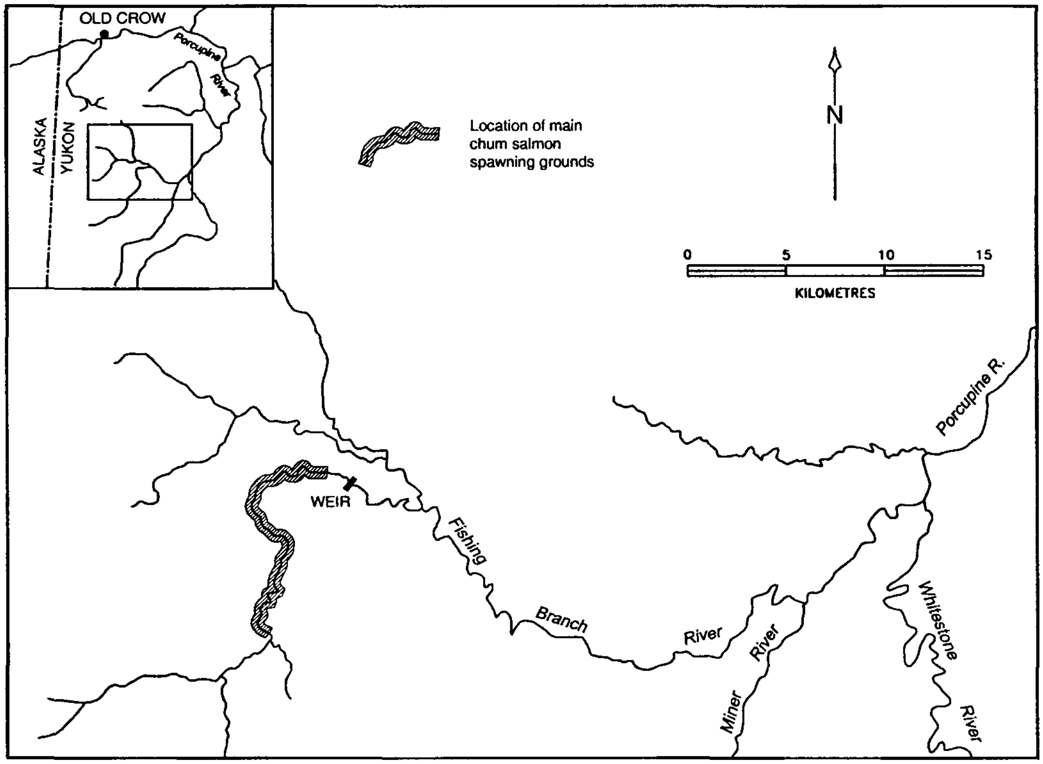

Figure 1. Map of the weir site on the Fishing Branch River.

The main channel of the river is clear, swift and meandering, with riffles, large exposed gravel bars and pools up to 2.5 m deep. The streambed consists primarily of large cobble (50-250 mm) and medium cobble (2-50 mm) with approximately 15% under 2 mm and 10% over 250 mm (Bryan 1973). Side channels are slow and have fine granular sediment over medium cobble (Bruce 1975).

Stream discharge fluctuates greatly due to regional precipitation and the spring snowmelt. Flood-like conditions in the fall after rainfall are not uncommon. Available flow measurements at the weir site range from 11.3 cubic metres per second in March 1972 (Steigenberger 1972) to 56.6 cubic metres per second in September 1972 (Elson 1975). A 15 km stretch of groundwater discharge in the headwaters of the south fork of the Fishing Branch River maintains open water in winter many kilometres downstream. The weir site is located in or close to the groundwater discharge area.

FISHERIES RESOURCE OVERVIEW

Species Present

The south fork of the Fishing Branch River is a major spawning ground for chum salmon, with historic escapement estimates ranging from 15,150 chum in 1982 (DFO files) to 353,282 in 1975 (Elson 1976). Chum spawning occurs in September and October. The groundwater flow provides a habitat suitable for spawning adults, incubating eggs and rearing juveniles when temperatures in the region are well below freezing (Steigenberger 1972).

Coho salmon (*Oncorhynchus kisutch*) spawn in the same area in October and November. Bryan (1973) reported that 150 coho juveniles were seined in a 300 square metre shallow riffle area of the Fishing Branch River in March 1972; 12 were seined in May 1972. Low numbers of adult coho salmon have been enumerated at the weir; however, the true magnitude of the escapement is unknown as the weir is removed due to weather conditions before the coho migration is complete.

In July and August, chinook salmon (*Oncorhynchus tshawytscha*) spawn in the groundwater area (Steigenberger et al 1973). As with coho, adult chinook have been enumerated at the weir, but except in 1998, the annual enumeration period likely did not cover the entire migration. The results of the 1998 study suggest that the number of chinook spawning upstream of the weir site is low (Doehle 1999).

Non-salmon species present in the area include: slimy sculpin (*Cottus cognatus*), round whitefish (*Prosopium cylindraceum*), Arctic grayling (*Thymallus arcticus*), and burbot (*Lota lota*). Northern pike (*Esox lucius*), humpback whitefish (*Coregonus clupeaformis*) and broad whitefish (*Coregonus nasus*) have been noted at the weir site, and were observed in the lower limits of the Fishing Branch River (Steigenberger et al 1973).

Utilisation

Non-Human: A variety of birds and mammals prey on Fishing Branch River fish stocks. Pre- and post-spawning adult chum salmon are preyed upon by grizzly bears, wolves, mink, fox, wolverine, marten, and eagles.

Within a 6.5 km reach located in the vicinity of the weir site, the grayling population has been estimated to be 9000 fish (Bruce 1973). In that study, stomach content analyses showed that the grayling diet included chum eggs and alevins. Other fish species native to the Fishing Branch River are believed to prey upon chum salmon eggs, alevins, and fry.

Human: Fishing Branch River salmon are harvested in Canada by the VGFN on the Porcupine River near Old Crow, and in Alaskan subsistence and commercial fisheries along the length of the Yukon River in Alaska. They may also be intercepted by the United States groundfish trawl fisheries in the Aleutian Islands area and the Gulf of Alaska, as well as in purse seine and salmon gillnet fisheries in the "False Pass" area near the south Alaska Peninsula. Until 1992, Fishing Branch River salmon may have been harvested in other offshore fisheries, namely:

(1) the Japanese high-seas mothership and land-based salmon gillnet fisheries,

(2) the high-seas squid gillnet fisheries in the North Pacific Ocean of Japan; the Republic of Korea, and the Republic of China (Taiwan),

(3) the foreign groundfish fisheries of the Bering Sea and Gulf of Alaska,

(4) the joint-venture groundfish fisheries of the Bering Sea and Gulf of Alaska, and

(5) the groundfish trawl fishery by many nations in the "Doughnut Hole" international waters area of the Bering Sea.

These fisheries harvested large numbers of salmon, some of which were likely of Yukon River origin, and therefore potentially of Fishing Branch River origin. However, international agreements have phased out most of these fisheries (JTC November 1993).

METHODS

SITE SELECTION

The weir was constructed on the south fork of the Fishing Branch River, approximately 31 km west of the confluence of the Miner River. This site corresponds to that used in all years of operation since 1972. Approximate co-ordinates are 66°32' latitude and 139°15' longitude (NTS map reference 116 J,K 1:50,000).

WEIR CONSTRUCTION

The weir at the Fishing Branch River was installed in July in order to enumerate potential chinook salmon (Doehle, 1999). This report focuses on the chum migration period.

Materials and methods used to construct the weir were similar to those used since 1985. The building blocks of the weir included approximately 15 iron tripods, plywood or aluminum/angle-iron stringers, electrical conduit, Vexar™ (plastic screening) and sandbags. (Over the years, plywood has been, and continues to be, replaced by aluminum.) A sampling chamber frame, constructed from rebar and angle-iron stringers, was placed where flow was the greatest (close to the middle of the river). This formed the apex of the weir. Tripods were placed out at a slight angle downstream from the sampling chamber to each bank of the river. The distance between tripods was 3m (10ft.). Stringers were bolted approximately one quarter and three quarters of the way up from the bottom of the upstream leg of each tripod. The conduit inserted at 5 cm (2") centers through the stringers provided the actual barrier to fish migration. Conduit was also inserted into the sampling chamber frame at the upstream end and sides. There was no gate at the downstream end of the structure. Fish passage through the weir was made possible by removal of two or three conduit (hereafter referred to as the "gate") from the upstream end of the chamber. A platform, supported by the weir itself and rebar driven into the river bottom, was placed by the side of the sampling chamber to facilitate enumeration and sampling.

Vexar™ mesh was laid out along the lower portions of the conduit to further stabilise the weir and prevent fish passage. Approximately 120 sandbags were positioned along the riverbed (on the upstream side of the weir) to hold the Vexar™ in place and to add stability to the conduit.

Lighting consisted of approximately fourteen 100 watt and 150 watt flood lights strung out across the weir and within the camp to facilitate night counting and for the safety of camp personnel. A gasoline-powered generator was used as the power source.

ENUMERATION

Weir

The 1998 salmon enumeration project administered by DFO commenced on 25 August. High water forced removal of the counting platform on the morning of August 28, and the weir gate was closed. On 30 August, the counting platform was re-installed. On 31 August, the gate was re-opened and normal monitoring procedures resumed. At no time did the water flow over the weir.

Migrants were counted and sexed as they passed through, or were dip-netted over, the upstream end of the counting chamber. Sexing was facilitated by marked sexual dimorphism and clear water.

For at least 50% of every hour during each four-hour shift, the gate was open or fish were being transferred over the gate manually using a dip-net. The weir was monitored for 20 hours each day. Between 0400 hrs and 0800 hrs consistently it was closed and not monitored. On days when live-sampling for age-length-sex data was conducted, the weir was closed for roughly 4 hours prior to sampling in order to allow sufficient numbers of fish to accumulate in, and slightly downstream of, the sampling chamber. Sampling for age-length-sex data was usually conducted between 1600 and 1800 hrs.

No gate existed at the downstream end of the sampling chamber. A trial installation using conduit was conducted from 14 September to 16 September in an attempt to facilitate capture of fish for both age-length-sex data and tag-related data. However, the gate installed proved to be of limited value due to the large size of the sampling chamber area and the inability to see into the water as a result of the turbulence caused by the upstream gate. Also, the high velocity of the water meant that fish evading dip-net sweeps often struck the downstream gate with considerable force. There were 2 cases of fish being pinned sideways against the downstream gate and expiring. The downstream gate also constituted a safety hazard for weir staff. These factors led to the removal of the downstream gate after two days of operation.

Examination of migrants for tag-related data (i.e. tags, pelvic fin-clip presence/absence, and tagging needle holes) was accomplished by two different methods. These were: (1) without handling; and (2) with handling, i.e. by dip-netting. The first method involved simply checking for tags, fin-clips and tagging needle marks as the fish swam through the weir gate. The second method involved actually handling the fish to allow a close visual inspection for the relevant criteria. Due to the clarity of the water the first method was remarkably effective, although the ability to document potential tagging needle marks, to determine tag identification numbers, and to verify observations was compromised. Approximately 53% of the 10,440 fish examined for tag-related data were handled.

Enumeration ceased on 22 October at 0300 hrs.

Aerial Surveys

A 15-minute aerial survey was conducted at 1400 hrs on 30 September. Two observers enumerated from a Bell 206B helicopter. The purpose of the survey was to count spawning chum pairs below the weir. From the air, it was difficult to separate the spawning pairs from the non-spawning pairs; the active redds, which were easily identified, were counted instead. An attempt was made to enumerate downstream redds upon demobilization on 23 October; however, time constraints and poor visibility due to weather conditions prevented this from occurring.

BIOLOGICAL SAMPLING

Live Fish

Live chum salmon migrating upstream were retrieved from the counting chamber with a dip-net and placed in a tub containing river water. The water was changed frequently to ensure adequate oxygen was available to the fish during sampling. Gender was recorded, and fork length was measured to the nearest 5 mm using a flexible plastic tape measure. Five scales were removed from the preferred area (located above the lateral line on an imaginary line extending from the posterior end of the dorsal fin to the anterior end of the anal fin) using forceps. After sampling, the fish were placed in the river upstream of the weir. An attempt was made to sample live fish in proportion to run timing. The target number of live samples was 750.

All chum salmon sampled for age, length and sex were also examined for tag-related data. The condition of the final 30 live fish sampled was recorded on a scale of 'good-fair-poor', based on a visual external assessment. 'Good' meant there was no external damage observed and 'poor' meant there was significant external damage (e.g. large, unhealed wounds). 'Fair' was intermediate between the two. All spaghetti-tagged fish recovered throughout the run were also examined based on this scale.

Carcasses

Samples were collected from carcasses of fish that had drifted downstream onto the weir in dead or moribund condition. Gender, post-orbital hypural length (POH), and fork length were recorded. The fork length was measured only on those fish with an intact caudal fin. Five scales were removed from each side of the fish. The number of scales removed from carcasses was greater than the number removed from live samples because handling time was not a concern. Pectoral fins and vertebrae were also collected from each fish for age determination. The amount of egg or milt in each carcass was estimated visually in order to gain information on individual spawning success.

The primary reasons for sampling carcasses were to assist in age interpretation of scales from live fish, and to determine the relationship between POH length and fork length. A target of 150 carcass samples was judged to be sufficient for these purposes. On sexually mature fish that have migrated large distances without feeding, bony structures provide more reliable age data than scales since they are not subject to the same degree of resorption. Development of a formula to describe the relationship between POH length and fork length was intended to allow inference of POH lengths from the fork lengths obtained from live fish. A measurement of POH length is more difficult to obtain than a fork length measurement from a live fish; however the POH length is often a more useful estimator of size since it is not influenced by the changes in morphology, (primarily kype development) that chum salmon exhibit as they approach sexual maturity.

DNA Collection

DNA samples were collected from juvenile coho salmon (O. kisutch). Standard Gee-type minnow traps baited with commercially canned pink salmon were used to catch the juveniles. The traps were set within 500 meters of the weir. The juvenile coho were placed in an >70% ethanol solution immediately after being removed from the traps. Fins were later collected from individual coho and placed in separate ethanol solutions. The target number of DNA samples was 200.

PHYSICAL PARAMETERS

Hydrological Data

Hydrological data (water temperature and level) was collected every four hours. Water temperature (°C) was recorded from the sampling platform, which was located in the section of river with greatest flow, using a hand-held alcohol thermometer. The temperature within the top six inches of the water column was measured.

A staff gauge was positioned close to the south bank approximately five metres downstream from the weir. Placement may have varied slightly from other years of the study. The purpose of the gauge, which was not zeroed or placed in the deepest section of the river, was not to measure absolute water level but to measure water level fluctuations.

Air Temperature

Air temperature (°C) was recorded on site every four hours using an alcohol thermometer.

DATA STORAGE AND SAMPLE ANALYSIS

Aging structures were sent to the morphology lab at the DFO Pacific Biological Station (PBS) in Nanaimo. A comparison of the pectoral fin rays and scales in the carcass sample assisted in the interpretation of scales obtained from live fish. Vertebra samples were not processed.

Raw data were entered into a computer spreadsheet (Excel) and are stored in the DFO office in Whitehorse. DNA samples were sent to the USFWS genetics laboratory in Anchorage, Alaska for incorporation into a baseline of Yukon River drainage coho salmon stocks. A portion of each sample was forwarded to the genetics laboratory at PBS.

RESULTS

ENUMERATION

Weir Counts

A total of 13,564 adult chum salmon was recorded passing the weir site in 1998 (Appendix 1). Migrating salmon were not observed moving through the weir until 31 August (see also Doehle 1999). The number of chum salmon migrating past the site after weir removal (22 October) is believed to be low; counts of 240 and 154 chum were recorded on 20 and 21 October, respectively. Twelve chum salmon were observed between 2400 hrs and 0200 hrs on 22 October.

Peak migration occurred in statistical week (SW) 40 (week ending 3 October 1998); 4,478 chum (33% of the total observed run) were enumerated during this time period

(Appendix 1). The highest daily count of 1,001 was recorded on 24 September (Figure 2). Fifty percent (50%) of the observed run had been enumerated by midnight 29 September.

One male chinook salmon was observed passing through the weir, on 1 September. Four coho were also observed passing through the weir, between 8 October and 22 October; three were male and one was of unknown gender.

The number of female chum counted through the weir was 8,161, while males numbered 5,403 (Appendix 1 and Figure 3). This represents a sex ratio of 60% female. The proportion of females generally increased over time, with a slight decrease in the final SW (Table 1). Weekly values ranged from a minimum of 49% in SW 37 (week ending 12 September 1998) to a maximum of 65% in SW 41 (week ending 10 October 1998).

Table 1. Weir count of chum salmon by sex in the Fishing Branch River, 1998.

Statistical Week	**Week Ending**	**Weir Count # Female**	**Weir Count Total**	**Weir Count % Female**
36	Sept. 5	51	95	54%
37	Sept. 12	97	197	49%
38	Sept. 19	476	868	55%
39	Sept. 26	2265	4104	55%
40	Oct. 3	2840	4478	63%
41	Oct. 10	1599	2458	65%
42	Oct. 17	392	614	64%
43	Oct. 24	441	750	59%
TOTAL		**8161**	**13564**	**60%**

Aerial Survey

The aerial survey conducted on September 30 encompassed approximately 4 km of river directly below the weir site. This survey identified eight active redds, all of which were within 500 meters of the weir. The number of spawning chum salmon present on these redds could not be accurately estimated due to high fish abundance in the vicinity of the redds, likely due to the proximity to the weir.

Tag-Related Data

The number of orange spaghetti tags counted through the weir was 189; 88 of these were recovered (86 through dip-netting at the weir and two through carcass sampling). Six grey tags were observed, two of which were recovered (along with radio tags). These tagged fish were dip-netted at the weir. In total, four radio tags were recovered (three at the weir and one upstream of the weir associated with a bear kill). The remote tracking station located just downstream of the weir recorded passage of additional radio tags (JTC 1998) but these were not documented at the weir. (Radio tagged fish were not obvious unless they possessed a spaghetti tag.) All spaghetti tags and radio tags recovered had been applied at Rampart, Alaska. The numbers of tags applied were 8,527 and 530 for spaghetti and radio tags respectively (JTC November 1998).

A total of 10,440 fish was examined for spaghetti tag loss. Four cases of tag loss were identified, one of which involved a radio-tagged fish. Two additional fish were observed with what appeared to be pelvic fin-clips; however, tagging needle marks were not observed on these fish and it is believed that the pelvic fin abnormality occurred naturally.

BIOLOGICAL SAMPLING

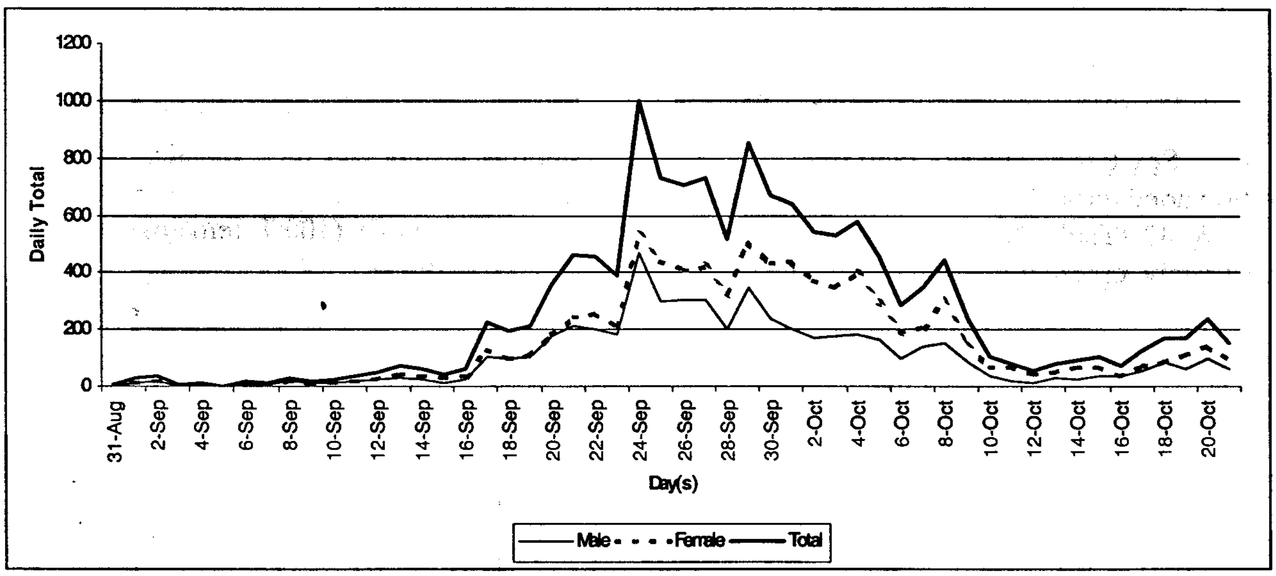

Figure 2. Daily counts of chum salmon, Fishing Branch River, 1998.

Live Fish

A total of 750 chum salmon was sampled to determine gender, fork length, and age. Sampling effort in relation to run timing is illustrated in Figure 3.

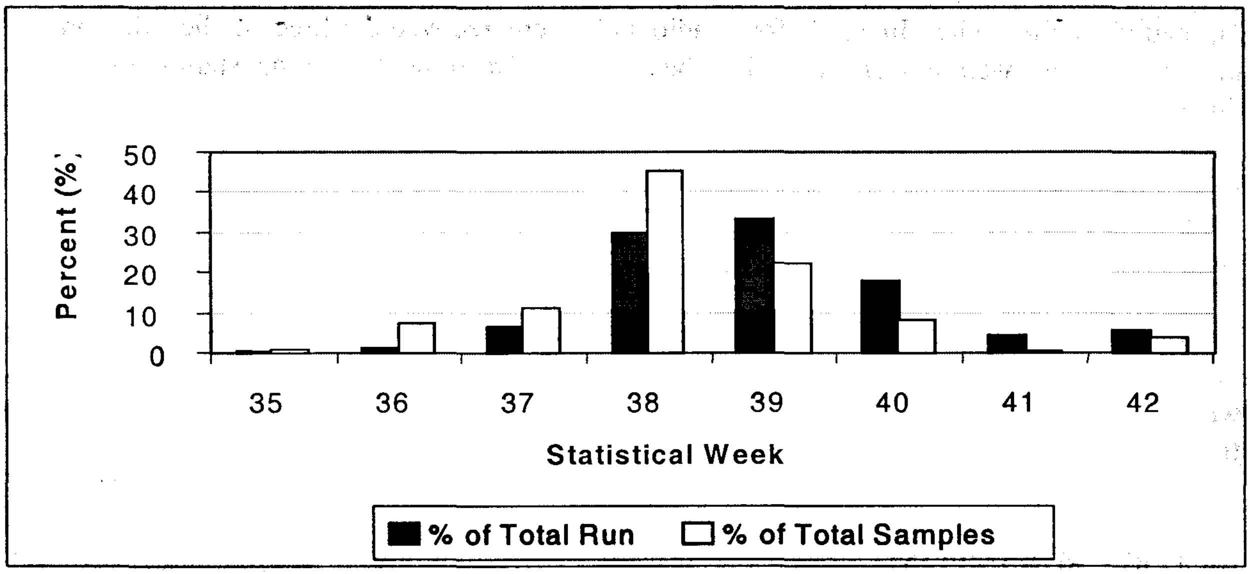

Figure 3. Sampling effort in relation to run timing by statistical week, Fishing Branch River, 1998

Sex Ratio: The sex ratio based on weighted sampling results was 68% female. The sex ratio varied throughout the sampling period, ranging from 44% female in SW 36 to 100% female in SW 42 (Table 2). The sex ratio observed in the SW 42 sample (100% female) may not accurately represent the actual ratio due to the small sample size (n=3).

Table 2. Sex composition of chum salmon by statistical week in the Fishing Branch River, 1998, as determined from the live samples.

Statistical Week	Week Ending	Weekly Sample	# Female	% Female
36	Sept. 5	9	4	44.4
37	Sept. 12	55	28	50.9
38	Sept. 19	86	57	66.3
39	Sept. 26	340	212	62.4
40	Oct. 3	165	111	67.3
41	Oct. 10	62	46	74.2
42	Oct. 17	3	3	100
43	Oct. 24	30	19	63.3
TOTAL		**750**	**480**	**67.8***

* weighted by weekly weir counts.

Size: The mean fork length (mm) for females (n=483) was 628, with a range of 550 to 715. The mean fork length (mm) for males (n=267) was 671, with a range of 580 to 755.

Fork length frequency distribution for females and males are illustrated in Figure 4.

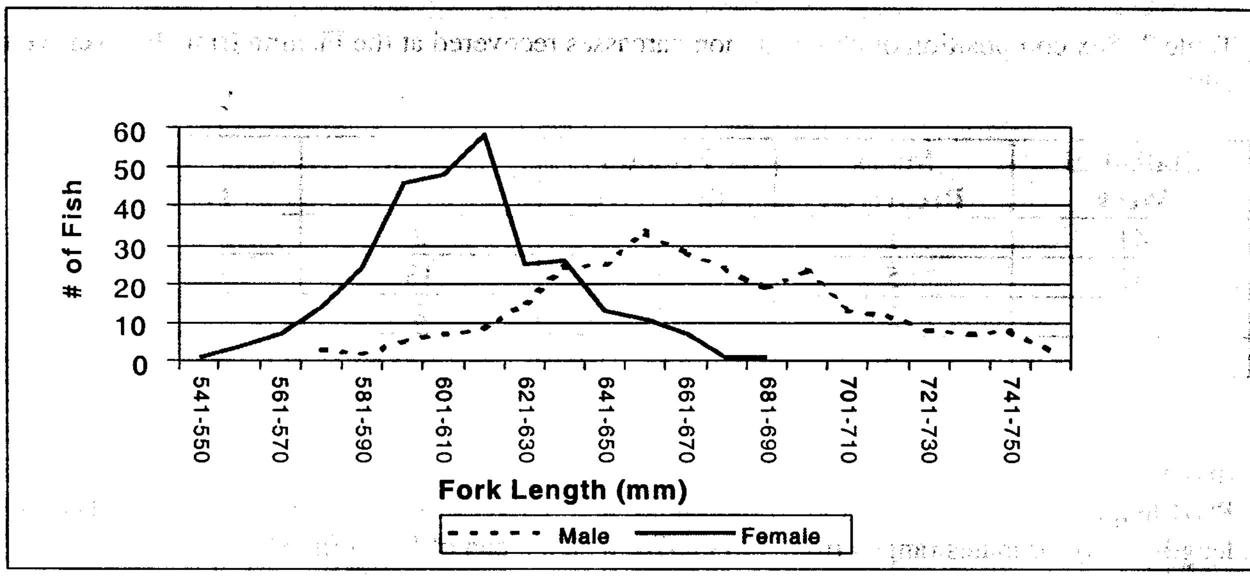

Figure 4. Fork length frequency of female and male chum salmon in Fishing Branch River, 1998, as determined by live sampling.

Age: Of the 750 scale samples sent to the morphology lab for analysis, 730 were aged. Most of the scales aged reflected some degree of resorption. Of the samples that did not yield ages, 6 (0.8%) were regenerated, 7 (0.9%) were too resorbed to interpret, 6 (0.8%) were wet and one (0.1%) was upside down. Age results were adjusted to reflect run timing by statistical week as determined from the weir count. Weighted results indicated that 4_1 was the predominant age class, comprising 79.9% (n=383) of females and 75.8% (n=205) of males. The next largest age class was 5_1, which contributed 19.7% (n=95) of females and 23.5% (n=63) of males. The smallest age class was made up of age 6_1 fish, which comprised 0.4% (n=2) of females and 0.8% (n=2) of males. With both sexes combined, the age composition was as follows: age 4_1 – 78.4%, age 5_1 – 21.1%, and age 6_1 – 0.5%.

Carcasses

Carcass sampling occurred in statistical weeks 41, 42, and 43. A total of 29 carcasses was recovered and sampled for gender, fork length, POH length, age, and sex product retention.

Sex Ratio

The sex ratio of carcasses recovered at the weir site was 72% female (n=29). Table 3 shows the sex composition of the weekly carcass samples. The egg/milt retention, estimated visually, averaged 20% (range 0% to 100%, std. dev. 33%) for females and 25% (range 5% to 85%, std. dev. 33%) for males.

Table 3. Sex composition of chum salmon carcasses recovered at the Fishing Branch River weir, 1998.

Statistical Week	Males Recovered	Females Recovered	Total Recovered	% Female
41	1	7	8	87.5
42	5	8	13	61.5
43	2	6	8	75
Total	**8**	**21**	**29**	**72.4 (avg.)**

Size: The mean fork length (mm) for male carcasses was 665, with a range of 605 to 750 (n=6). The mean fork length (mm) for females was 596.7, with a range of 540 to 665 (n=12). POH length (mm) for females averaged 488.6, and ranged from 450 to 535, (n =21). The POH length (mm) for males ranged from 480 to 570, with a mean of 513.8 (n=8).

Linear regression analysis was conducted in order to develop a formula that could be used to convert fork length to POH length for live fish. Females and males were treated separately. The relationship for females was not significant at a 95% confidence level. The relationship for males was significant ($p_{critical}=0.05$, r-square=0.98) and was as follows: $y = 0.66x + 79.5$, where x = fork length and y = POH length.

Age: There were age structure samples from 29 carcasses sent to the DFO morphology lab for age analysis. Using pectoral fin rays, all were aged. As with the sample obtained from live chum salmon, age 4_1 fish dominated, contributing 61.9% (n=13) of females, and 75.0% (n=6) of males. Age 5_1 fish comprised 33.3% (n=7) of the females and 25.0% (n=2) of the males sampled. There was only one age 6_1 fish, a female. With both sexes combined, the sex ratio was as follows: age 4_1 – 65.5%, age 5_1 – 31.0%, and age 6_1 – 3.4%.

DNA Collection

Fins were taken from 74 juvenile coho salmon for the purpose of DNA analyses. Due to limited trapping success, this was short of the target number of 200.

No adult coho salmon were captured for DNA sampling.

PHYSICAL PARAMETERS

Water Level

Water level readings taken at midnight each day are shown in Figure 5. Using all level readings taken (i.e. not just those taken at midnight), the water level fluctuated by 0.37 m. The highest water level observed was 0.88 m (recorded on August 28), while the lowest was 0.51 m (recorded on October 19, 21, and 22).

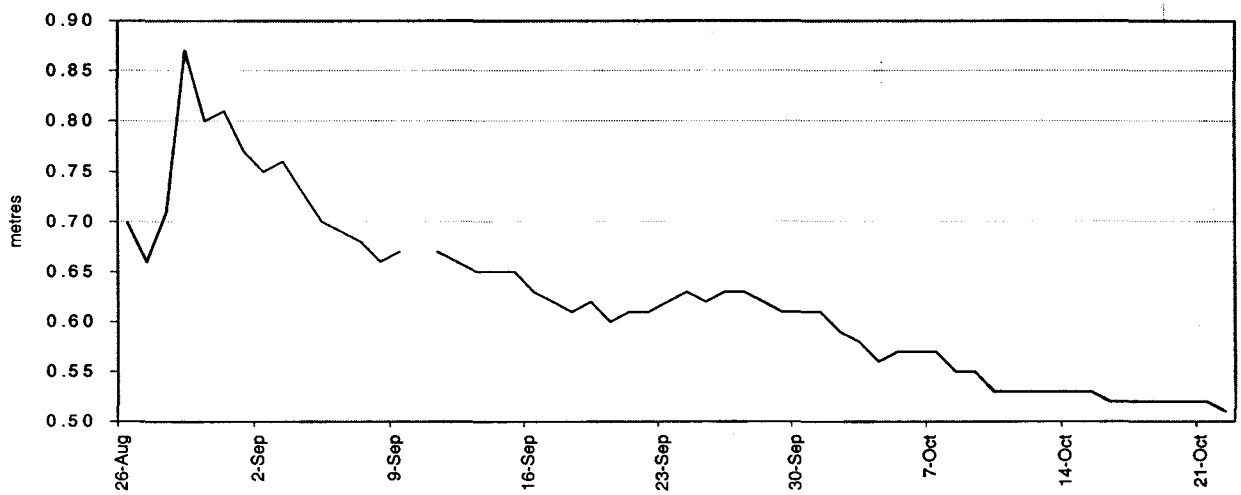

Figure 5. Daily water level as recorded at the Fishing Branch River weir site, 1998.

Water Temperature

Water temperature readings taken at midnight each day are shown in Figure 6. The average midnight water temperature for the enumeration period was 4.0°C. Using all temperature measurements taken, the maximum water temperature recorded was 7°C (observed on 28 August), while the minimum was 1.5°C (observed on 9,10, 11, and 13 October).

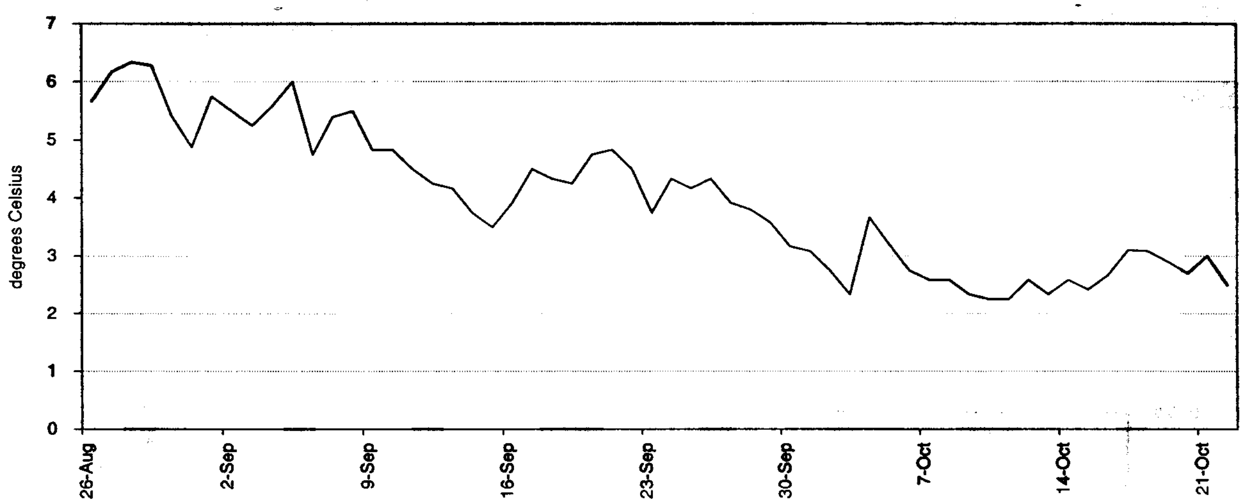

Figure 6. Daily water temperature as recorded at the Fishing Branch River weir site, 1998.

Air Temperature

Figure 7 shows air temperatures taken at midnight daily. The average midnight air temperature for the enumeration period was -1.8°C. Using all readings taken, temperature ranged from 21°C on 3 September to -21°C on 9 October.

Figure 7. Daily air temperature as recorded at the Fishing Branch River weir site, 1998.

DISCUSSION

The 1998 Fishing Branch River chum salmon escapement count was the lowest on record, 10% less than the previous low of 15,150 chum salmon, recorded in 1982 (DFO files). Poor fall chum escapements were observed throughout the Yukon River drainage in 1998 (JTC 1998).

The contribution of females to the escapement (60%) was slightly above the recent cycle average (approximately 54%). The slight predominance of females observed at the weir most years may be a factor of gear selectivity in downstream fisheries. Males may be more susceptible to entanglement in gillnets because of their more pronounced snouts and teeth, particularly as they approach maturity (Milligan et al, 1986). Since many fish were not handled to determine gender, there was potential for error due to observer bias, high densities, light conditions, and low water clarity after rainfall. Comparisons were made with the sex composition in the sample for age and length data, in which all fish were handled and closely inspected. The pooled and weighted sample (n=750) was 68% female, slightly higher than the percentage in the total escapement count. Possible sources of error for the sample are those resulting from sample rate, timing, and method (for example, gender bias in sample selection).

The aerial survey count was 8 redds. At the time of the survey, the weir count was 59% complete. The observance of these redds is an indication that there is suitable spawning habitat immediately downstream of the weir. While the amount of spawning activity in this location annually may be insignificant relative to total, it would be useful to conduct a survey each season to monitor it, to see if there is an increasing trend. A survey in October could provide a more complete estimate, provided viewing conditions were suitable.

The male chum salmon were observed to be larger than the females, with mean fork lengths measuring 671 and 628 mm, respectively (Figure 6). Similar size differences between the sexes have been documented on other tributaries of the Yukon River drainage (McBride et al.).

The predominance of females observed in the carcass sample may be an artifact of low sample size; examination of previous years' data has shown that males are more frequently recovered from the weir than females. It is probable that more dead or moribund fish passed the weir site after demobilization. Studies have shown that female chum salmon remain near their redds until they die, are more susceptible to predation than males, and less likely than males to be washed far downstream (Schroder 1982).

It is likely that the apparent age composition differences between live fish and carcasses were also influenced by sampling error, specifically small sample size. However, as noted in the methods section, the primary purpose of the carcass sampling was not to characterise the group of fish that drifted as far downstream as the weir site. Rather, it was to provide structures that would assist in scale interpretation for aging purposes, and to determine the relationship between POH length and fork length.

Between 1994 and 1997, the annual return of Fishing Branch River chum salmon is estimated to have averaged 79,000 fish[1]. In comparison, using the same assumptions, the 1998 return is estimated to have been only 25,000 chum salmon. The pre-season forecast was for a return of 112,000 chum salmon, which was above average (JTC February 1998). The 1998 return to the Fishing Branch River fell far short of expectations.

Based on the footnoted assumptions, the U.S. harvest of Fishing Branch River chum salmon is estimated to have been 5,400 fish, about 72% below the 1994-1997 average. In Canada, the harvest of 6,100 fall chum in the VGFN fishery near Old Crow was approximately 41% above average.

Chum salmon run shortfalls were seen elsewhere in the drainage. The Sheenjek River escapement count of 33,000 fish was likely the poorest escapement to that river since monitoring began in 1981[2], and was 49% below the minimum escapement goal. The Chandalar River count of 75,800 chum was 67% below the 1995-1997 average. The U.S. harvest of fall chum salmon was curtailed; it was 73% below the 1994-1997 average harvest of approximately 235,000 fish (all Yukon River drainage stocks combined). The preliminary estimate of the total return of Yukon River drainage fall chum was 49% to 55% below the preseason forecast of 880,000 fish (JTC November 1998).

While the cause of the drainage-wide run shortfall has not been positively identified, there is evidence to suggest that it was due to poor marine survival. Anomalous conditions observed in 1997 and 1998 in the Bering Sea, including high surface temperatures, (Schumacher et al, 1999) may have played a role.

ACKNOWLEDGEMENTS

Thanks are due to the weir staff, Harvey Kassi and Stringer Charlie of the Vuntut Gwitchin First Nation (VGFN) for their hard work and commitment over the course of the season. Thanks also to Louise Naylor of DFO and Paul Doehle of the VGFN for assisting with administration and logistics. The authors would also like to thank Pam Vust for data processing, as well as Sandy Johnston of DFO and Lee-Ann Chevrette for suggestions and editorial work.

[1] This period was chosen because it represents the most recent cycle – the predominant age of spawning Fishing Branch River chum is four years. The return is defined as the number of adult fish returning to the Yukon River from marine areas. Run size calculations are based on the following assumptions: (a) 30% of the U.S. catch is composed of Canadian-origin fish; (b) the U.S. harvests Canadian stocks in the same ratio as: upper Yukon River border escapement-to-Porcupine River border escapement; and (c) the Porcupine River border escapement consists of the Old Crow catch plus the Fishing Branch River escapement. A key assumption is that the Fishing Branch River upstream of the weir site is the only chum spawning area in the Canadian portion of the Porcupine River drainage.

[2] Escapement to the Sheenjek River is estimated using sonar.

REFERENCES

Bergstrom, D.J., S.E. Merkouris, K. Shultz, R. Holder, G. Sandone, D. Schneiderhan, L.H. Barton, and D. Mesiar. 1991. Annual Management Report Yukon Area, 1989. Alaska Department of Fish and Game - Division of Commercial Fisheries.

Bruce, P.G. 1975. A preliminary study of fish species other than salmon found in the Fishing Branch River, Yukon Territory in September, 1973. In Steigenberger, L.W., Elson, M.S., R.T. Delury (eds.) 1975.

Bryan, J.E. 1973. The influence of pipeline development on aspects of research conducted in 1971 and 1972. Fisheries and Oceans Canada.

Delury, R.T., L.W. Steigenberger, and M.S. Elson. 1975. Aspect of the historical and present day fisheries exploitation 1972, 1973, and 1974. In Steigenberger, L.W., Elson, M.S., R.T. Delury (eds.) 1975.

Doehle, P. 1999. Chinook Salmon Assessment in the Fishing Branch River, Yukon Territory, 1998. Canada/United States Yukon River Panel Restoration and Enhancement Fund, Project RE-25-98.

JTC. 1993. Yukon River Salmon Season Review for 1993 and Technical Committee Report. November 1993.

JTC. 1998. Yukon River Joint Technical Committee Report. February 1998.

JTC. 1998. Yukon River Salmon Season Review for 1998 and Technical Committee Report. November 1998.

Koski, K.V. 1975. The survival and fitness of two stocks of chum salmon (Onchorynchus keta) from egg deposition to emergence in a controlled-stream environment at Big Beef Creek. Ph.D. thesis. University of Washington, Seattle, WA. 212 p.

McBride, D.N., Hamner, H.H., and L.S. Buklis. 1983. Age, sex, and size of Yukon River catch and escapement, 1982. Alaska Department of Fish and Game, Regional Information Report Number 3A93-10, Anchorage, Alaska.

Milligan, P.A., Rublee, W.O., Cornett, D.D., and R.A.C. Johnston. 1986. The distribution and abundance of chum salmon (Onchorynchus keta) in the upper Yukon River basin as determined by a radio-tagging and spaghetti-tagging program: 1982-1983. Fisheries and Oceans Canada.

Oswald, E.T. and J.R. Senyk. 1997. Ecoregions of the Yukon Territory. Fisheries and Environment Canada. pp 115.

Schumacher, J.D., N.A. Bond, R.D. Brodeur, P.A. Livingstone, J.M. Napp and P.J. Stabeno. 1999. Changes in the Physical Environment of the Eastern Bering Sea and Some Potential Consequences for Biota. Extended Abstract prepared for presentation at Alaska Department of Fish and Game 6th Alaska Salmon Workshop: Ocean - Climate Change And Variability In Fishery Recruitment. Version 3.1 produced 12 February 1999.

Schroder, S.L. 1982. The role of sexual selection in determining the overall mating patterns and mating choice in chum salmon. Ph.D. thesis. University of Washington, Seattle, WA. 274pp.

Steigenberger, L.W. 1972. Preliminary information on the winter classification of the rivers in the northern Yukon, their physical and chemical characteristics and the fish statistics of the various water bodies examined during the first Yukon pipeline winter survey, March 1972. In Steigenberger, L.W., Elson, M.S., and Delury, R.T., (eds.) 1975.

Appendix 1. Daily, weekly and cumulative counts of chum salmon, Fishing Branch Weir, 1998

Statistical Week	Date	Male	Female	Daily Total	Cumul. Total	Weekly Total	Timing %	% Male	% Female	Examined for tag loss	Tag loss observed	Cumul. Examined for tag loss
36	31-Aug	2	4	6	6	95	0.04	33.3	66.7	6	N	6
	1-Sep	14	15	29	35		0.3	48.3	51.7	0	N	6
	2-Sep	17	21	38	73		0.5	44.7	55.3	0	N	6
	3-Sep	2	6	8	81		0.6	25.0	75.0	2	N	8
	4-Sep	6	5	11	92		0.7	54.5	45.5	11	N	19
	5-Sep	3	0	3	95		0.7	100.0	0.0	3	N	22
37	6-Sep	9	12	21	116	197	0.9	42.9	57.1	21	N	43
	7-Sep	6	7	13	129		0.9	46.2	53.8	13	N	56
	8-Sep	16	16	32	161		1.2	50.0	50.0	32	N	88
	9-Sep	10	6	16	177		1.3	62.5	37.5	0	N	88
	10-Sep	15	11	26	203		1.5	57.7	42.3	0	N	88
	11-Sep	17	21	38	241		1.8	44.7	55.3	38	N	126
	12-Sep	27	24	51	292		2.1	52.9	47.1	51	N	177
38	13-Sep	28	43	71	363	868	2.7	39.4	60.6	58	N	235
	14-Sep	27	36	63	426		3.1	42.9	57.1	44	N	279
	15-Sep	13	28	41	467		3.4	31.7	68.3	33	N	312
	16-Sep	26	35	61	528		3.9	42.6	57.4	55	N	367
	17-Sep	101	125	226	754		5.5	44.7	55.3	6	N	373
	18-Sep	95	98	193	947		7.0	49.2	50.8	0	N	373
	19-Sep	102	111	213	1160		8.5	47.9	52.1	26	N	399
39	20-Sep	174	184	358	1518	4104	11.2	48.6	51.4	30	N	429
	21-Sep	215	246	461	1979		14.5	46.6	53.4	40	N	469
	22-Sep	198	257	455	2434		17.9	43.5	56.5	100	N	569
	23-Sep	181	207	388	2822		20.7	46.6	53.4	80	N	649
	24-Sep	472	529	1001	3823		28.1	47.2	52.8	0	N	649
	25-Sep	296	436	732	4555		33.5	40.4	59.6	732	Y (A)	1381
	26-Sep	303	406	709	5264		38.7	42.7	57.3	709	N	2090

Appendix 1 (cont'd)

Statistical Week	Date	Male	Female	Daily Total	Cumul. Total	Weekly Total	Timing %	% Male	% Female	Examined for tag loss	Tag loss observed	Cumul. Examined for tag loss
40	27-Sep	306	423	729	5993	4478	44.0	42.0	58.0	729	N	2819
	28-Sep	198	321	519	6512		47.8	38.2	61.8	519	N	3338
	29-Sep	347	504	851	7363		54.5	38.5	61.5	901	Y (B)	4239
	30-Sep	238	430	668	8031		59.4	35.6	64.4	668	N	4907
	1-Oct	199	440	639	8670		64.1	31.1	68.9	639	N	5546
	2-Oct	171	373	544	9214		68.0	31.4	68.6	544	N	6090
	3-Oct	179	349	528	9742		71.9	33.9	66.1	528	N	6618
41	4-Oct	185	395	580	10322	2458	76.2	31.9	68.1	580	Y (C)	7198
	5-Oct	163	294	457	10779		79.5	35.7	64.3	457	N	7655
	6-Oct	95	191	286	11065		81.6	33.2	66.8	286	N	7941
	7-Oct	141	209	350	11415		84.2	40.3	59.7	350	N	8291
	8-Oct	151	296	447	11862		87.5	33.8	66.2	447	Y (D)	8738
	9-Oct	85	150	235	12097		89.2	36.2	63.8	235	N	8973
	10-Oct	39	64	103	12200		90.0	37.9	62.1	103	N	9076
42	11-Oct	18	64	82	12282	614	90.6	22.0	78.0	82	N	9158
	12-Oct	14	41	55	12337		91.0	25.5	74.5	55	N	9213
	13-Oct	32	50	82	12419		91.6	39.0	61.0	82	N	9295
	14-Oct	27	64	91	12510		92.3	29.7	70.3	91	N	9386
	15-Oct	37	64	101	12611		93.0	36.6	63.4	101	N	9487
	16-Oct	38	38	76	12687		93.6	50.0	50.0	76	N	9563
	17-Oct	56	71	127	12814		94.5	44.1	55.9	127	N	9690
43	18-Oct	85	86	171	12985	750	95.7	49.7	50.3	171	N	9861
	19-Oct	61	112	173	13158		97.0	35.3	64.7	173	N	10,034
	20-Oct	99	141	240	13398		98.8	41.3	58.8	240	N	10,247
	21-Oct	61	93	154	13552		99.9	39.6	60.4	154	N	10,428
	22-Oct	3	9	12	13564		100.0	25.0	75.0	12	N	10,440
Total		**5403**	**8161**	**13564**	**13564**	**13564**	**100**	**39.8**	**60.2**	**10,440**		**10,440**

Appendix 2. Fishing Branch River Weir Operations, 1998

Date	Gate Open	Gate Closed Fish Dip-netted Over Gate	Gate Closed No fish Dip-netted	Hours		
				Gate Open	Gate Closed Fish Dip-netted	Gate Closed No Fish Dip-netted
1-Sep		2400 - 400	400 - 800	0	20	4
		800 - 2400				
2-Sep		2400 - 400	400 - 800	0	20	4
		800 - 2400				
3-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1600	1600 - 2000			
		2000 - 2400				
4-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1600	1600 - 2000			
		2000 - 2400				
5-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1600	1600 - 2000			
		2000 - 2400				
6-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1200	1200 - 1600			
		1600-2400				
7-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
8-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
9-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
10-Sep		800 - 1200	2400 - 800	0	12	12
		1600 - 2400	1200 - 1600			
11-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
12-Sep		2400 - 400	400 - 800	0	16	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
13-Sep	200 - 400	2400 - 200	400 - 800	2	15	7
		800 - 1200	1200 - 1300			
		1300 - 1400	1400 - 1600			
		1600 - 2400				
14-Sep	200 - 400	2400 - 200	400 - 800	2	15	7
		800 - 1200	1200 - 1400			
		1600 - 2400	1500 - 1600			
15-Sep	200 - 400	2400 - 200	400 - 800	2	14	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
16-Sep	200 - 400	2400 - 200	400 - 800	2	15	7
		800 - 1200	1200 - 1300			
		1300 - 1400	1400 - 1600			
		1600 - 2400				
17-Sep	200 - 400	2400 - 200	400 - 800	14	2	8
	800 - 1200	1600 - 2400	1200 - 1600			

Appendix 2. (cont'd)

Date	Gate Open	Gate Closed Fish Dip-netted Over Gate	Gate Closed No fish Dip-netted	Hours		
				Gate Open	Gate Closed Fish Dip-netted	Gate Closed No Fish Dip-netted
18-Sep	2400 - 400		400 - 800	16	0	8
	800 - 1200		1200 - 1600			
	1600 - 2400					
19-Sep	2400 - 400	1600 - 1700	400 - 800	15	1	8
	800 - 1200		1200 - 1600			
	1600 - 2400					
20-Sep	2400 - 400	1600 - 1700	400 - 800	15	1	8
	800 - 1200		1200 - 1600			
	1600 - 2400					
21-Sep	2400 - 400		400 - 800	16	0	8
	800 - 1200		1200 - 1600			
	1600 - 2400					
22-Sep		2400 - 400	400 - 800	8	8	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
23-Sep		2400 - 400	400 - 800	2	14	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
24-Sep	800 - 1200	2400 - 400	400 - 800	15	2	7
		1300 - 1400	1200 - 1300			
		1600 - 2400	1400 - 1600			
25-Sep		2400 - 400	400 - 800	17	0	7
		800 - 1200	1200 - 1400			
		1400 - 1500	1500 - 1600			
		1600 - 2400				
26-Sep		2400 - 400	400 - 800	14	2	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
27-Sep		2400 - 400	400 - 800	13	3	8
		800 - 1200	1200 - 1600			
		1600 - 2400				
28-Sep	2400 - 400	800 - 1200	400 - 800	4	12	8
		1600 - 2400				
29-Sep	800 - 1200	2400 - 400	400 - 800	8	8	8
	2000 - 2400	1600 - 2000	1200 - 1600			
30-Sep	2400 - 400	1600 - 1800	400 - 800	12	4	8
	800 - 1200	2000 - 2200				
	1800 - 2000					
	2200 - 2400					
1-Oct	2400 - 400	800 - 1200	400 - 800	6	13	5
		1300 - 2400	1200 - 1300			
2-Oct	2400 - 400	1000 - 1400	400 - 800	8	10	6
	800 - 1000	1600 - 2200	1400 - 1600			
	2200 - 2400					
3-Oct	2400 - 400	1000 - 1200	400 - 800	8	8	8
	800 - 1000	1600 - 2200	1200 - 1600			
	2200 - 2400					

Appendix 2. (cont'd)

Date	Gate Open	Gate Closed Fish Dip-netted Over Gate	Gate Closed No fish Dip-netted	Hours		
				Gate Open	Gate Closed Fish Dip-netted	Gate Closed No Fish Dip-netted
4-Oct	2400 - 400	800 - 1200	400 - 800	8	11	5
	1800 - 2000	1300 - 1800	1200 - 1300			
	2200 - 2400	2000 - 2200				
5-Oct	800 - 2400	2400 - 400	400 - 800	18	2	4
6-Oct	2400 - 400	1500 - 1600	400 - 800	16	1	7
	800 - 1200		1200 - 1500			
	1600 - 2400					
7-Oct	2400 - 400	1600 - 1800	400 - 800	9	6	8
	800 - 1200	2000 - 2400	1200 - 1600			
	1900 - 2000					
8-Oct	2400 - 400	1600 - 1700	400 - 800	18	1	5
	800 - 1500		1500 - 1600			
	1700 - 2400					
9-Oct	2400 - 400	1100 - 2100	400 - 800	12	8	4
	800 - 1100					
	2100 - 2400					
10-Oct	2400 - 400	1600 - 1700	400 - 800	15	1	8
	800 - 1200		1200 - 1600			
	1700 - 2400					
11-Oct	2400 - 400		400 - 800	20		4
	800 - 2400					
12-Oct	2400 - 400	1600 - 1800	400 - 800	14	3	7
	800 - 1200	1300 - 1400	1200 - 1300			
	1800 - 2400		1400 - 1600			
13-Oct	2400 - 400		400 - 800	19		5
	800 - 1500		1500 - 1600			
	1600 - 2400					
14-Oct	2400 - 400		400 - 800	16		8
	800 - 1200		1200 - 1600			
	1600 - 2400					
15-Oct	2400 - 400		400 - 800	20		4
	800 - 2400					
16-Oct	2400 - 400		400 - 800	20		4
	800 - 2400					
17-Oct	2400 - 200		2000 - 800	18		6
	800 - 2400					
18-Oct	2400 - 200		200 - 800	18		6
	800 - 2400					
19-Oct	2400 - 200	1200 - 1400	200 - 800	14	2	8
	800 - 1000		1000 - 1200			
	1400 - 2400					
20-Oct	2400 - 200	1200 - 1400	200 - 800	15	2	7
	800 - 1100		1100 - 1200			
	1400 - 2400					
21-Oct	2400 - 200		200 - 800	18		6
	800 - 2400					
22-Oct	2400 - 200		200 - 2400	2		22
FINAL HOUR TOTALS				**489**	**380**	**378**