Abundance and Run Timing of Adult Salmon in Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2003

Alaska Fisheries Data Series Number 2004-5

by

Gareth K. VanHatten

Key words: Chinook salmon, chum salmon, resistance board weir, abundance estimate, run timing, sex ratio, age composition, fish length, Gisasa River

U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, 101 12th Avenue, Box 19, Room 222, Fairbanks, Alaska, 99701

June 2004

Disclaimers

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the Federal Government.

The U.S. Department of Interior prohibits discrimination on the basis of race, color, national origin, religion, sex, age, or disability. If you believe that you have been discriminated against in any program, activity, or facility operated by the U.S. Fish and Wildlife Service or if you desire further information please write to:

U.S. Department of the Interior
Office for Equal Opportunity
1849 C Street, NW
Washington, D.C. 20240

The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided funding support for this project through the Fisheries Resource Monitoring Program, under Agreement Number FIS 03-013.

The correct citation for this report is:

VanHatten, G. K. 2004. Abundance and run timing of adult salmon in Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2003. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Alaska Fisheries Data Series Number 2004-5, Fairbanks, Alaska.

Abstract.—Chinook and summer chum salmon escapement counts from the Gisasa River assist state and federal managers in making decisions during in-season run activity, provide post-season evaluation of various management practices, and assist in developing future run projections. From June 28 to August 3, 2003, a resistance board weir was used to estimate 1,886 Chinook and 24,820 summer chum salmon in the Gisasa River within the Koyukuk River drainage, Alaska. The Chinook salmon escapement was 71% of the 1995-2002 average of 2,663 fish. Female Chinook salmon comprised 35% of the run. The average female Chinook salmon length was 810 mm and the average male length was 710 mm. The summer chum salmon escapement was 49% of the 1995-2002 average of 50,908 fish. Female summer chum salmon comprised 48% of the run. The average female summer chum salmon length was 559 mm and the average male length was 591 mm. The information collected in 2003 will add to the database, which began in 1995, for Chinook and summer chum salmon populations in the Gisasa River. Due to the complexity of the Yukon River fishery, the difficulty in managing specific stocks, and the scarcity of comparative long-term trend data, it is vital to continue collecting information from individual salmon populations within the Koyukuk and Yukon River drainages.

Table of Contents

List of Tables

List of Figures

List of Appendices

Introduction

The Yukon River drainage, encompassing 854,700 km^2, is among the largest producers of wild Chinook *Oncorhynchus tshawytscha* and chum salmon *O. keta* stocks in North America (Daum and Osborne 1999). Chinook, chum, and coho salmon *O. kisutsh* use 1,931 km of the Yukon River and 675 km of the Koyukuk River for migration routes to spawning grounds (Buklis and Barton 1984; Bergstrom et al. 1995). The Yukon River is the only North American drainage that has two distinct runs of chum salmon, which are referred to as summer and fall runs (Vania et al. 2002). Genetic studies reported by Wilmot et al. (1992) showed that these two runs are genetically distinct and differ in life history and phenotypic characteristics, i.e., run timing, spawning locations, and morphology. Chinook and summer chum salmon run timing in the Yukon River starts in late-May and continue through mid-July (Wiswar 2000). Fall chum salmon run timing starts in late-June and continues through early-September (Vania et al. 2002). Chinook salmon spawn throughout the Yukon River drainage, whereas summer chum salmon spawn mainly in the lower and middle reaches (Minard 1996). Fall chum salmon spawn in the upper portions of the Yukon River drainage.

In accordance with the Alaska National Interest Lands Conservation Act (ANILCA) of 1980, the U.S. Fish and Wildlife Service (USFWS) is obligated to conserve the natural diversity of fish and wildlife resources on National Wildlife Refuge lands. Additional USFWS goals are to conserve fish and wildlife populations, maintain habitats in their natural diversity, and provide the opportunity for continued subsistence use by local residents (USFWS 1993).

Due to recent declines in Yukon River salmon runs, particularly summer and fall chum salmon, there have been harvest restrictions, complete fishery closures, and spawning escapements below management goals on many tributaries in the Yukon River drainage (Kruse 1998; Vania et al. 2002). The need to collect accurate escapement estimates from these tributaries is required to determine exploitation rates and spawner recruit relationships (Labelle 1994), as well as, determining if genetic diversity and sustainable harvest are being provided for (Vania et al. 2002). Management of the Yukon River fishery is complex due to the inability to determine specific stock abundance and run timing, overlapping multi-species salmon runs, the increasing efficiency of the fishing fleet, allocation issues, and the immense size of the Yukon River drainage (Vania et al. 2002). In an attempt to understand this mixed stock salmon fishery, several studies are being conducted along the main stem of the Yukon River that provide managers with information required to assess the in-season run of Chinook and summer chum salmon (Vania and Golembeski 2000). Other studies monitor returning salmon escapements to tributaries within USFWS refuge boundaries. An example is the weir on the Gisasa River, a tributary in the lower Koyukuk River that flows through the Koyukuk National Wildlife Refuge. This project provides data that meet USFWS and refuge goals by obtaining accurate escapement and stock assessment estimates of adult salmon that are important components in refining fishery management practices.

Historically, escapement information from salmon stocks has been collected by aerial surveys. The Alaska Department of Fish and Game, Division of Commercial Fisheries (ADF&G-DCF) has conducted these surveys on several index tributaries within the Koyukuk River drainage intermittently since 1960 (Barton 1984). Unfortunately,

aerial surveys are highly variable and only represent an index of instantaneous escapement. To record total escapements, aerial survey methods have been replaced with more accurate population assessment methods like counting towers, floating weirs, and sonar. To collect baseline information on salmon stocks in the Koyukuk River drainage, the U.S. Fish and Wildlife Service-Fairbanks Fish and Wildlife Field Office (USFWS-FFWFO) and Bureau of Land Management (BLM) have designed and operated stock status and escapement projects in five different Koyukuk River tributaries. Floating weirs have been operated by USFWS-FFWFO in the Gisasa River since 1994 (Wiswar 2001), in Henshaw Creek since 2000 (VanHatten and Wiswar, in preparation), and in the South Fork Koyukuk River in 1996 and 1997 (Wiswar 1997a, 1998a). The South Fork Koyukuk River weir study was discontinued in 1997 due to persistent high water conditions (Wiswar 1998a). A counting tower has been operated by BLM in Clear Creek, Hogatza River, since 1995 (VanHatten 1999; C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication). A floating weir project was also conducted in 2002 in the Kateel River by USFWS-FFWFO, but was discontinued after one season.

The mouth of the Koyukuk River is located 818 km up-river from the mouth of the Yukon River in western interior Alaska (Figure 1). The Koyukuk River originates in the Brooks Range, and the river flows southwesterly, passing through the Kanuti (Kanuti Refuge) and Koyukuk/Nowitna (Koyukuk Refuge) National Wildlife Refuges before entering the Yukon River. The Kanuti Refuge is located on the upper Koyukuk River near the villages of Allakaket, Alatna, and Bettles. The Koyukuk Refuge is located on the lower Koyukuk River near the villages of Koyukuk, Galena, Huslia, and Hughes.

This report describes the 2003 Gisasa River escapement project conducted by USFWS-FFWFO. The Gisasa River is located on the lower Koyukuk River, 90 km upriver from the mouth of the Koyukuk River, and produces a large escapement of Chinook and summer chum salmon (Figure 1). Historical data on Chinook and summer chum salmon in the Gisasa River consist of aerial surveys from 1960 to 1998 (Barton 1984; Appendix 1) and counts from a resistance board weir from 1994 to 2002 (VanHatten 2002; Appendix 1). Historical aerial survey data from 1960-1961 and incomplete weir data from 1994 were excluded from trend analysis. Chinook salmon estimates from aerial surveys averaged 401 fish annually from 1974-1983 (range=45-951) and 1,074 fish annually from 1985-1998 (range=144-2,775). Summer chum salmon estimates from aerial surveys averaged 15,088 fish from 1974-1983 (range 334-56,904) and 6,278 fish annually from 1985-1998 (range 450-13,232; Barton 1984; Schultz et al. 1993; Vania et al. 2002). Between 1995 and 2002 the Gisasa River weir study recorded Chinook salmon escapements that ranged from 1,927 to 4,023 (Figure 2) and summer chum salmon escapements that ranged from 9,452 to 151,839 (Melegari and Wiswar 1995; Melegari 1996, 1997; Wiswar 1997b, 1998b, 1999, 2000; VanHatten 2002; Figure 3).

The objectives of this study were to: 1) determine daily escapement and run timing of adult salmon; 2) determine sex and size composition of adult salmon; and 3) determine the presence and movement of resident fish.

Study Area

Climate conditions of the Koyukuk River drainage are characteristically continental with seasonal temperature variations and very low precipitation. The air temperature ranges from 18^{o} C in summer to -57^{o} C in winter (USFWS 1993). The hydrology of this area is very dynamic throughout the year with high water levels during spring and low water levels in summer. The lower river sections are characteristically more uniform in appearance with gradual sloping mud banks and emergent shoreline vegetation (USFWS 1993). The substrate composition along the river varies from gravel and cobble in high velocity sections to mud and silt in eddies and sloughs.

The Gisasa River is located 90 km upriver from the mouth of the Koyukuk River in the western interior of Alaska (Figure 1). The headwaters originate in the Nulato Hills and the river flows 112 km northeast, passing through the Koyukuk Refuge, before draining into the Koyukuk River (65^{o} 16' N latitude, 157^{o} 40' W longitude, USGS 1:63,360 series, Kateel River B-4 quadrangle).

The weir site is located approximately 4 km upriver from the mouth of the Gisasa River. This site was selected for its optimal width (76 m), depth (0.5 m), and substrate composition (medium size gravel 25-50 mm).

Methods

Weir Operation

A resistance board weir was operated to collect escapement counts and biological information from spawning adult salmon as they migrated into the Gisasa River. The start date of the project was based on previous years' run timing data. The criterion for selecting the end date of the project was based on when the daily percent of the total run for each species was less than 1% for two or more consecutive days.

Construction and installation of the weir were described by Tobin (1994). Each picket of the weir was made of 2.5 cm (inside diameter), schedule-40, polyvinyl chloride (PVC) electrical conduit and spaced, center-to-center, 6.7 cm apart (Stewart 2002). During visual inspection, the weir was cleaned of debris and fish carcasses. A live trap, installed near mid-channel allowed salmon and resident species to be recorded as they migrated upstream.

Biological Data

Run timing and abundance of adult Chinook and summer chum salmon were estimated by recording and plotting the number of each species of fish migrating through the weir each day. Because the non-salmon species were not handled, it was difficult to identify different whitefish species; therefore all whitefish species were grouped under the subfamily Coregoninae.

The counting schedule was designed to count migrating fish species 24 hours a day, 7 days a week for the duration of the project. The daily counting schedule began at 0001 hours and ended at 2400 hours. During high water events when the counting schedule was interrupted, missing daily salmon estimates were generated by linear

interpolation. The 24-hour counting period was divided into four 6-hour periods, with crew members being assigned to a specific period. During time periods when biological sampling was conducted, an additional crew member would assist.

A stratified random sampling scheme was used to collect age, length, and sex ratio information from both adult salmon species. Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with single statistical weeks being defined as the strata. Each statistical week was defined as beginning on Monday and ending on Sunday. Sampling began at the beginning of each week and, generally, was conducted over a 3-4 day period. A goal of 160 fish per species per week was set.

Scales were used for ageing salmon with age class information being reported using the European technique (Foerster 1968). Three scales were collected from Chinook salmon and one scale from summer chum salmon. Scales were sampled from the area located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both adult salmon species were sent to ADF&G-DCF for processing. Daily sex ratios were collected using two methods: 1) sex of each fish was recorded when sampling for age and length; and 2) sex of fish were opportunistically identified throughout the day. Crew members physically handled and identified sex of the fish as they migrated into the trap. Sex of each fish was determined by secondary sex characteristics. The daily escapement count and sex ratios were reported to the USFWS-FFWFO. Lengths of Chinook and summer chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL).

Data Analysis

Within a week, the proportion of the samples composed of a given sex or age, p_{ij}, were calculated as:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j},$$

where n_{ij} is the number of fish by sex i or age i sampled in week j, and n_j is the total number of fish sampled in week j. The variance of p_{ij} was calculated as:

$$\hat{v}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1 - \hat{p}_{ij})}{n_j - 1}.$$

Sex and age compositions for the total run of Chinook and summer chum salmon of a given sex/age, p_i, were calculated as:

$$\hat{p}_i = \sum \left(\frac{N_j}{N} \right) \hat{p}_{ij},$$

and N_j equals the total number of fish of a given species passing through the weir during week j, and N is the total number of fish of a given species passing through the weir during the run. Variances of sex and age compositions for the run were calculated as:

$$\hat{v}(\hat{p}_i) = \sum_{j=1} \left(\frac{N_j}{N} \right)_j^2 \hat{v}(\hat{p}_{ij}) .$$

Results

Weir Operation

The weir was installed and operational from June 28 to August 3, 2003. The counting schedule was halted for one day (July 4) due to high water. Spawning activity of summer chum salmon, e.g., females digging redds immediately upstream of the weir, resulted in areas where gravel accumulated on the weir panels. These areas and floating debris were cleaned off the weir on a daily basis. The operation of the weir was halted on August 3.

Biological Data

There were 1,886 Chinook salmon, 24,820 summer chum salmon, and 92 resident fish estimated migrating through the weir in 2003 (Table 1). The most abundant resident species was Arctic grayling *Thymallus arcticus* (N=34), followed by longnose sucker *Catostomus catostomus* (N=31), unidentified species (N=14), northern pike *Esox lucius* (N=11), and whitefish spp. *Coregoninae* (N=2). The 2003 Chinook and summer chum salmon estimates are conservative estimates due to fish passing the weir site before and after the weir was operational. The July 4 Chinook and summer chum salmon daily counts were interpolated as 13 and 313, respectively, due to high water conditions.

Chinook salmon.—The 2003 Chinook salmon estimate was 71% of the 1995-2002 average of 2,663 fish. The first Chinook salmon was counted on June 28 and the last Chinook salmon was counted on August 3, 2003 (Table 1; Figure 4). The first quartile migrated through the weir by July 10 and the median migration date was July 13, 2003. There were 513 Chinook salmon sampled for age composition with 41 (8%) of the samples classified as unknown (Table 2). Age composition of Chinook salmon sampled made up five age groups: age-1.5 (1%), age-1.4 (24%), age-1.3 (69%), age-1.2 (6%), and age-1.1 (<1%). The seasonal Chinook salmon sex ratio was comprised of 35% females (Table 3). The average female Chinook salmon length was 810 mm with a range from 590 to 1,090 mm (Table 4). The average male Chinook salmon length was 710 mm with a range from 305 to 930 mm.

Summer chum salmon.—The 2003 summer chum salmon estimate was 49% of the 1995-2002 average of 50,908 fish. The first summer chum salmon was counted on June 28 and the last summer chum salmon was counted on August 3, 2003 (Table 1; Figure 5).

The first quartile migrated through the weir by July 8 and the median migration date was July 13. There were 828 summer chum salmon sampled for age composition with 124 (15%) of the samples classified as unknown (Table 5). Age composition of summer chum salmon sampled made up four age groups: age-0.5 (2%), age-0.4 (29%), age-0.3 (68%), and age-0.2 (1%). The seasonal summer chum salmon sex ratio comprised 48% females (Table 6). The average female summer chum salmon length was 559 mm with a range from 480 to 655 mm (Table 4). The average male summer chum salmon length was 591 mm with a range from 505 to 690 mm.

Discussion

Weir Operation

The Gisasa River weir was operational throughout the field season except for July 4, when the counting schedule was halted due to high water. During the high water event the water rose high enough to impede counting but the weir remained intact. High water conditions can submerge the weir panels, which possibly allowed fish to migrate past the weir undetected (Tobin 1994). When the weir was operational the picket spacing within the trap and weir panels were close enough together (3.6 cm opening) to prevent adult Chinook and summer chum salmon from passing through the weir. However, it is possible some of the smaller fish species, e.g., Arctic grayling and whitefish, likely passed through the weir undetected.

Escapement and Run Timing

The Gisasa River Chinook salmon escapement counts fluctuated between 1995 and 2003 (Figure 2). From 1995 to the present the Chinook salmon escapement counts ranged from 1,886 in 2003 to 4,023 in 1995. The summer chum salmon counts also fluctuated greatly, ranging from 9,452 in 1999 to 151,839 in 1996 (Figure 3). In general, the overall Yukon River Chinook and summer chum salmon run sizes have improved during the last three years (JTC 2002). However the recent increase in the size of Yukon River Chinook and summer chum salmon stocks throughout the drainage was not as apparent for the two Koyukuk River stocks, Gisasa River and Henshaw Creek, monitored by USFWS-FFWFO. The Gisasa River Chinook and summer chum salmon data from 2000 to 2003 were compared to the Henshaw Creek data for the same time period (Figures 6 and 7). Instead of showing an increasing trend, the Gisasa River and Henshaw Creek salmon stocks fluctuated over the past four years. In general, during the four-year period the Chinook salmon counts had similar trends, with the highest counts occurring in 2001 (Figure 6). From 2000 to 2003 summer chum salmon escapements had similar trends between the two USFWS-FFWFO monitoring sites with the exception of the 2002 counts (Figure 7).

To date nine years of Chinook and summer chum salmon data have been collected from the Gisasa River, which allowed for short-term trends to be analyzed. The Gisasa River data showed that Chinook salmon escapement counts alternated between years, with odd years being highest except in 2003 (Figure 2). The Gisasa River summer chum salmon escapement counts could possibly represent high and low production periods

(Figure 3). The 1995 and 1996 escapement counts could represent the high end of a production period and starting in 1997, a low period of production started and continued through 2003 (Figure 3). To fully understand the high-low production cycle of the Gisasa River salmon stocks a longer time series is needed. In addition, there are few long-term escapement projects conducted in the Yukon River drainage to allow historical comparisons to be made between Gisasa River stock characteristics and other streams.

Information from a Chinook salmon radio telemetry study on the lower main stem Yukon River showed that there was a small proportion of tagged Chinook salmon that migrated into the Koyukuk River (J. Eiler, National Oceanic and Atmospheric Administration, personal communication). The small sample size precluded drawing any conclusions on migration timing of Koyukuk River stocks. A future telemetry study within the Koyukuk River could answer many of the present questions on run timing characteristics of these stocks. In general salmon migration rates vary along the Yukon River main stem with those salmon traveling the farthest having faster traveling rates (JTC 2002). For example, Yukon River Chinook salmon that migrate to upper tributaries of the Yukon River have been documented to travel an average speed of about 54.4 km/day, which is about 20.1 km/day faster than those fish migrating (34.3 km/day) to tributaries along the lower portions of the Yukon River (J. Eiler, National Oceanic and Atmospheric Administration, personal communication). The driving force behind salmon migration patterns may be explained by one or more factors: 1) populations with the farthest distance to travel may enter the Yukon River earlier than those traveling to lower river tributaries; 2) entry time into the Yukon River may be similar, but the fish going farther swim faster; or 3) milling time may be inversely proportional to the distance salmon need to travel to their spawning grounds (Molyneaux et al. 1997).

Historical data show that Chinook and summer chum salmon run timing may be associated with environmental conditions on the Yukon River. Data from 1995-2003 show that Chinook salmon run timing follows a similar pattern to ice-out dates on the lower Yukon River (Figure 8; B. Busher, ADF&G, personal communication). The ice conditions on the Yukon River may affect the river entry dates and migration rates of both Chinook and summer chum salmon traveling to their spawning grounds. Generally, late ice-out years had fish returning to the Gisasa River later than early ice-out years. Data from ice-out conditions on the lower Yukon River and run timing of Gisasa River Chinook and summer chum salmon indicate that run timing on the Gisasa River could be related to the date when the Yukon River becomes ice free (Figure 8).

Age Distribution

The Chinook and summer chum salmon age class information collected on the Gisasa River was limited with respect to sample size, but the sample sizes were fairly well distributed over the course of the run. In general, Chinook salmon populations are made up of six different age classes, with six-year-old fish dominating (Groot and Margolis 1998). The 2003 Gisasa River Chinook salmon population was dominated by age-1.3 fish (69%) and represented by five different age classes. This trend was also noticed on Henshaw Creek where the Chinook salmon population was dominated by age-1.3 (50%) and represented by five different age classes (Figure 9; Table 7). In general, summer chum salmon are comprised of age-0.2, age-0.3, and age-0.4 fish with age-0.3

fish dominating (Groot and Margolis 1998). In 2003, the Gisasa River summer chum salmon population was dominated by age-0.3 fish (68%) and represented by four different age classes. Henshaw Creek summer chum salmon escapement was also dominated by age-0.3 fish (85%; Figure 10; Table 8). The reasons for the differences in age class dominance between Gisasa River and Henshaw Creek summer chum salmon populations are unknown at this time.

Scale samples may give a biased estimation of age in Henshaw Creek and Gisasa River Chinook and summer chum salmon. Age analysis studies, scale versus vertebrae, have been conducted which show that ageing salmon by scales can underestimate the age of salmon and thus cause the ages to be biased low (Wiswar 1997a,b). The underestimate may be attributed to the outer edge of the scale being reabsorbed by the fish as they migrate upriver. A 1996 ageing study conducted in the South Fork Koyukuk River showed a difference between chum salmon ages when using scales and vertebrae (Wiswar 1997a). The South Fork Koyukuk River study collected samples from two different time periods with the first sampling period having only a 44% agreement and the second sampling period having a 79% agreement between scale and vertebrae analysis. An additional chum salmon study was conducted during the same year in the Gisasa River. This study showed that the scale and vertebrae aging were in 73% agreement and the scale readings were biased low (Wiswar 1997b). It is recommended that studies be initiated to determine if scale samples give an unbiased estimator of age in stream-specific stocks of Chinook and summer chum salmon.

Sex Ratio

The proportion of females on the spawning grounds is indicative of the general status of the run (Groot and Margolis 1998). Generally during the salmon spawning period, there are higher proportions of males on the spawning grounds early in the run while higher proportions of females arrive later (Beacham and Starr 1982). The Gisasa River Chinook salmon sex ratio for the season was 35% females with a high of 54% during the fifth statistical week. The Henshaw Creek Chinook salmon sex ratio for the season was 36% females with a high of 51% females during the fourth statistical week (Figure 11). The Gisasa River summer chum salmon sex ratio for the season was 48% females, with a high of 50% females during the second statistical week. The Henshaw Creek summer chum salmon sex ratio for the season was 50% females with a high of 55% females during the last statistical week (Figure 12). It is not fully understood how the Gisasa River Chinook and summer chum salmon sex ratios affect the overall status of these populations.

Conclusion

The operation of weirs on tributaries within the Koyukuk River drainage is an important management tool. Both federal and state managers rely upon weir data to investigate population dynamics of Chinook and summer chum salmon. In 2003 daily counts and sex ratios of Gisasa River Chinook and summer chum salmon were provided throughout the season. The information collected will add to a growing database for

Chinook and summer chum salmon populations and will allow post-season evaluation of management actions. Escapement data from Gisasa River and Henshaw Creek show that not all tributaries along the Koyukuk River are similar. With this in mind, management practices cannot be solely based on information collected from only one tributary. Due to the complexity of the Yukon River fishery and the difficulty in managing specific stocks, it is vital to continue long-term monitoring of individual salmon populations, especially Gisasa River and Henshaw Creek in the Koyukuk River drainage. The justification for long-term monitoring of Gisasa River and Henshaw Creek Chinook and summer chum salmon stocks can be supported by the results in this report which show there are differences in run timing, sex ratios, age distribution, and escapement numbers between the two systems.

Acknowledgments

Special appreciation is extended to those who contributed to this project: crew leader Kevin Saylor; and crew members Carrie Forbes, Evan Schick, Eric Cherko, and Jordan Houghton.

The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided funding support for the Gisasa River project (FIS 03-013) through the Fisheries Resource Monitoring Program.

Staff of the Koyukuk National Wildlife Refuge is thanked for their support in setting up and taking down the Gisasa River camp, and Yukon Eagle Air for transportation services.

References

Barton, L.H. 1984. A catalog of Yukon river salmon spawning escapement surveys. Alaska Department of fish and Game - Division of Commercial Fisheries. Fairbanks, Alaska.

Beacham, T.D. and P. Starr. 1982. Population biology of chum salmon, *Oncorhynchus keta*, from the Fraser River, British Columbia. Fishery Bulletin 80(4): 813-825.

Bergstrom, D.J., A.C. Blaney, K.C. Schultz, R.R. Holder, G.J. Sandone, D.J. Schneiderhan, and J.H. Barton. 1995. Annual management report Yukon area, 1993. Alaska Department of fish and Game, Regional Information Report Number 3A95-10, Anchorage, Alaska.

Buklis, L.S. and L.H. Barton. 1984. Yukon River fall chum salmon biology and stock status. Alaska Department of Fish and Game-Division of Commercial Fisheries, Information Leaflet Number 239, Fairbanks, Alaska.

Cochran, W.G. 1977. Sampling techniques, 3rd edition. John Wiley and sons, New York.

Daum, D.W. and B.M. Osborne. 1999. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1998. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fisheries Technical Report Number 50, Fairbanks, Alaska.

Foerster, R.E. 1968. The sockeye salmon, *Oncorhynchus nerka*. Fisheries Research board of Canada, Bulletin 161, Ottawa, Canada.

Groot C. and L. Margolis. 1998. Pacific Salmon Life Histories. UBC Press, Vancouver, B.C.

JTC (United States/Canada Yukon River Joint Technical Committee). 2002. Yukon River salmon season review for 2002 and technical committee report. Prepared by the United States/Canada Yukon River Joint Technical Committee, Whitehorse, Yukon Territory.

Kruse, G.E. 1998. Salmon run failures in 1997-1998: A link to anomalous ocean conditions? Alaska Fisheries Resource Bulletin 5(1):55-63.

Labelle, M. 1994. A likelihood method for estimating pacific salmon escapement based on fence counts and mark-recapture data. Canadian Journal of Fisheries Aquatic Science 51: 552-556.

Melegari, J.L. and D.W. Wiswar. 1995. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife, Alaska, 1994. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fishery Data Series Number 95-1, Fairbanks, Alaska.

Melegari, J.L. 1996. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife, Alaska, 1995. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fishery Data Series Number 96-1, Fairbanks, Alaska.

Melegari, J.L. 1997. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife, Alaska, 1996. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fishery Data Series Number 97-1, Fairbanks, Alaska.

Minard, J. 1996. Age, sex, and length of Yukon River salmon catches and escapements, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report Number 3A96-16, Anchorage, Alaska.

Molyneaux, D.B., L. Dubois, and A. Morgan. 1997. George River weir salmon escapement project, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Informational Report Number 3A97-27, Anchorage, Alaska.

Schultz, K.C., R.R. Holder, L.H. Barton, D.J. Bergstrom, C. Blaney, G.J. Sandone, D.J. Schneiderhan. 1993. Annual management report for subsistence, personal use, and commercial fisheries of the Yukon area, 1992. Alaska Department of Fish and Game, Regional Information Report Number 3A93-10, Anchorage, Alaska.

Stewart, R. 2002. Resistance board weir panel construction manual 2002. Alaska Department of Fish and Game, Regional Information Report Number 3A02-21, Anchorage, Alaska.

Tobin, J.H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Kenai, Alaska.

USFWS. 1993. Fishery Management Plan-Koyukuk National Wildlife Refuge. Fairbanks Fishery Resource Office, Fairbanks, Alaska.

VanHatten, G.K. 1999. Abundance and run timing of adult summer run chum salmon (*Oncorhynchus keta*) in Henshaw (Sozhelka) Creek, 1999. Tanana Chiefs Conference, Inc. Water Resources Report 99-3, Fairbanks, Alaska.

VanHatten, G.K. 2002. Abundance and run timing of adult salmon in three tributaries of the Koyukuk River, Alaska, 2001. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Alaska Fisheries Data Series Number 2002-5, Fairbanks, Alaska.

Vania, T. and V. Golembeski. 2000. Summer season preliminary fishery summary Yukon area, Alaska, 2000. Alaska Department of Fish and Game - Division of Commercial Fisheries. Regional Information Report Number 3A00-42, Anchorage, Alaska.

Vania, T., V. Golembeski, B.M. Borba, T.L. Ligneau, J.S. Hayes, K.R. Boeck, and W.H. Busher. 2002. Annual Management Report Yukon and Northern Areas 2000. Alaska Department of Fish and Game, Regional Information Report Number 3A02-29, Anchorage, Alaska.

Wilmot, R.L., R. Everett, W.J. Spearmann, and R. Baccus. 1992. Genetic stock identification of Yukon River chum and chinook salmon 1987 to 1990. Progress report. U.S. Fish and Wildlife Service. Alaska Fish and Wildlife Research Center, Fisheries Management Service, Anchorage, Alaska.

Wiswar, D.W. 1997a. Abundance and run timing of adult salmon in the South Fork Koyukuk River, Kanuti National Wildlife Refuge, Alaska, 1996. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Alaska Fisheries Data Series 97-5, Fairbanks, Alaska.

Wiswar, D.W. 1997b. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 1997. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Alaska Fisheries Data Series Number 98-3, Fairbanks, Alaska.

Wiswar, D. W. 1998a. Abundance and run timing of adult salmon in the South Fork Koyukuk River, Kanuti National Wildlife Refuge, Alaska, 1997. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Alaska Fisheries Data Series Number 98-1, Fairbanks, Alaska.

Wiswar, D.W. 1998b. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife, Alaska, 1997. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fishery Data Series Number 98-3, Fairbanks, Alaska.

Wiswar, D.W. 1999. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife, Alaska, 1998. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fishery Data Series Number 99-1, Fairbanks, Alaska.

Wiswar, D.W. 2000. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife, Alaska, 1999. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Fishery Data Series Number 2000-1, Fairbanks, Alaska.

Wiswar, D.W. 2001. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2000. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office, Alaska Fisheries Data Series Number 2001-1, Fairbanks, Alaska.

Table 1.—Daily and cumulative (Chinook and summer chum salmon only) counts of fish migrating through Gisasa River weir, Alaska, 2003. cum = cumulative. Asterisks indicate first, middle, and third quartile of run. Bold numbers indicate interpolated estimates.

	Chinook salmon		Summer chum salmon		Arctic grayling	Longnose sucker	Unidentified	Northern pike	Whitefish spp.
Date	Daily	cum	Daily	cum	Daily	Daily	Daily	Daily	Daily
28-Jun	2	2	248	248	0	0	0	1	0
29-Jun	8	10	230	478	0	2	0	0	0
30-Jun	8	18	561	1,039	0	0	0	0	0
1-Jul	25	43	890	1,929	0	1	0	0	0
2-Jul	32	75	655	2,584	0	1	0	1	0
3-Jul	19	94	138	2,722	0	2	0	0	0
4-Jul	**13**	107	**313**	3,035	0	0	0	0	0
5-Jul	7	114	487	3,522	0	0	0	0	0
6-Jul	23	137	609	4,131	3	1	1	0	0
7-Jul	36	173	1,181	5,312	0	2	1	0	0
8-Jul	73	246	957	*6,269	2	6	1	0	0
9-Jul	186	432	1,222	7,491	0	1	1	4	0
10-Jul	222	*654	1,004	8,495	0	3	1	0	0
11-Jul	109	763	1,455	9,950	1	1	2	1	0
12-Jul	88	851	1,303	11,253	3	2	1	0	0
13-Jul	120	*971	1,361	*12,614	2	3	1	1	1
14-Jul	26	997	909	13,523	2	0	0	1	0
15-Jul	79	1,076	1,287	14,810	0	0	0	0	0
16-Jul	41	1,117	529	15,339	1	0	0	0	0
17-Jul	94	1,211	1,321	16,660	0	0	0	0	0
18-Jul	217	*1,428	1,924	*18,584	3	0	1	0	0
19-Jul	102	1,530	1,439	20,023	4	1	2	2	0
20-Jul	94	1,624	823	20,846	4	2	0	0	1
21-Jul	50	1,674	626	21,472	3	1	0	0	0
22-Jul	57	1,731	432	21,904	4	0	0	0	0
23-Jul	11	1,742	264	22,168	0	0	0	0	0
24-Jul	53	1,795	411	22,579	0	1	0	0	0
25-Jul	8	1,803	209	22,788	0	0	1	0	0
26-Jul	22	1,825	168	22,956	1	0	0	0	0
27-Jul	8	1,833	212	23,168	0	0	0	0	0
28-Jul	9	1,842	310	23,478	1	1	0	0	0
29-Jul	16	1,858	316	23,794	0	0	0	0	0
30-Jul	6	1,864	264	24,058	0	0	1	0	0
31-Jul	3	1,867	120	24,178	0	0	0	0	0
1-Aug	13	1,880	204	24,382	0	0	0	0	0
2-Aug	0	1,880	207	24,589	0	0	0	0	0
3-Aug	6	1,886	231	24,820	0	0	0	0	0
Total	1,886		24,820		34	31	14	11	2

Table 2.—Percent weekly and seasonal age estimates of Chinook salmon sampled at Gisasa River weir, Alaska, 2003. Standard errors are in parentheses. Season totals are calculated from weighted abundance of weekly totals. Sample size is from fish sampled for age analysis.

				Brood year and age				
				1996	1997	1998	1999	2000
Time period	Run size (N)	Sample size (n)	Unknown	1.5	1.4	1.3	1.2	1.1
Jun 28-Jul 6	137	88	4	0 (0.0)	14 (3.7)	83 (4.1)	3 (2.0)	0 (0.0)
Jul 7-13	834	177	7	2 (1.0)	21 (3.1)	70 (3.5)	7 (2.0)	0 (0.0)
Jul 14-20	653	140	18	0 (0.0)	23 (3.6)	72 (3.8)	5 (1.8)	1 (0.7)
Jul 21-27	209	48	8	2 (2.1)	36 (7.0)	56 (7.2)	6 (3.5)	0 (0.0)
Jul 28-Aug 3	53	19	4	5 (5.3)	68 (11.0)	27 (10.4)	0 (0.0)	0 (0.0)
Season total	1,886	472	41	1 (0.5)	24 (2.0)	69 (2.2)	6 (1.2)	<1 (0.2)

Table 3.—Sex ratios of Chinook salmon sampled at Gisasa River weir, Alaska, 2003. Standard errors are in parentheses. Season totals are calculated from weighted abundance of weekly totals. Sample size is from fish sampled for age analysis and those fish sexed opportunistically. Estimated number of females is based on un-rounded percent female from weekly sample.

Time period	Run size (N)	Sample size (n)	Percent female	Estimated number of females
Jun 28 - Jul 6	137	105	45 (4.9)	56
Jul 7 - 13	834	187	37 (3.5)	308
Jul 14 - 20	653	212	28 (3.1)	182
Jul 21 - 27	209	86	43 (5.4)	90
Jul 28 - Aug 3	53	41	54 (7.9)	28
Season total	1,886	631	35 (2.0)	663

Table 4.—Length at age of female and male Chinook and summer chum salmon sampled at Gisasa River weir, Alaska, 2003.

	Female					Male				
		Mid-eye to fork length (mm)					Mid-eye to fork length (mm)			
Age	N	Mean	Median	SE	Range	N	Mean	Median	SE	Range
Chinook salmon										
1.1	0					1	305	305	-	-
1.2	0					26	521	523	10.1	360-640
1.3	86	744	738	7.4	590-890	243	723	730	3.4	530-910
1.4	88	867	860	5.2	720-1,011	23	804	810	11.7	670-930
1.5	5	946	900	36.8	900-1,090	0				
Season total	179	810	830	6.6	590-1,090	293	710	730	5.0	305-930
Summer chum salmon										
0.2	2	533	533	12.5	520-545	2	523	523	17.5	505-540
0.3	229	551	550	1.8	480-640	264	571	580	1.8	510-685
0.4	80	582	583	2.9	485-655	117	613	620	3.0	535-690
0.5	6	573	563	13.0	540-620	4	630	630	12.9	600-660
Total	317	559	560	1.7	480-655	387	591	590	1.7	505-690

Table 5.—Percent weekly and seasonal age estimates of summer chum salmon sampled at Gisasa River weir, Alaska, 2003. Standard errors are in parentheses. Season totals are calculated from weighted abundance of weekly totals. Sample size is from fish sampled for age analysis.

				Brood year and age			
				1997	1998	1999	2000
Time period	Run size (N)	Sample size (n)	Unknown	0.5	0.4	0.3	0.2
Jun 28-Jul 6	4,131	167	40	1 (0.8)	43 (3.8)	56 (3.9)	0 (0.0)
Jul 7-13	8,483	144	14	2 (1.2)	31 (3.9)	65 (4.0)	2 (1.2)
Jul 14-20	8,232	134	21	3 (1.5)	26 (3.8)	71 (3.9)	0 (0.0)
Jul 21-27	2,322	129	25	0 (0.0)	12 (2.9)	88 (2.9)	0 (0.0)
Jul 28-Aug 3	1,652	130	24	1 (0.8)	23 (3.7)	75 (3.8)	1 (0.8)
Season total	24,820	704	124	2 (0.7)	29 (2.0)	68 (2.0)	1 (0.4)

Table 6.—Sex ratios of summer chum salmon sampled at Gisasa River weir, Alaska, 2003. Standard errors are in parentheses. Season totals are calculated from weighted abundance of weekly totals. Sample size is from fish sampled for age analysis and those fish sexed opportunistically. Estimated number of females is based on un-rounded percent female from weekly sample.

Time period	Run size (N)	Sample size (n)	Percent female	Estimated number of females
Jun 28-Jul 6	4,131	2,494	44 (1.0)	1,819
Jul 7-13	8,483	4,101	50 (0.8)	4,282
Jul 14-20	8,232	5,373	49 (0.7)	4,031
Jul 21-27	2,322	1,578	48 (1.3)	1,126
Jul 28-Aug 3	1,652	1,183	47 (1.5)	776
Season total	24,820	14,729	48 (0.4)	12,034

Table 7.—Seasonal age class percentages of Chinook salmon at Gisasa River and Henshaw Creek weirs, Alaska, 2003. Percentages are calculated from weighted weekly totals.

Study sites	Run size (N)	Sample size (n)	Unknown	Percent of age class				
				1.5	1.4	1.3	1.2	1.1
Gisasa River	1,886	472	41	1	24	69	6	<1
Henshaw Creek	748	304	17	1	29	50	18	1

Table 8.—Seasonal age class percentages of summer chum salmon at Gisasa River and Henshaw Creek weirs, Alaska, 2003. Percentages are calculated from weighted weekly totals.

Study sites	Run size (N)	Sample size (n)	Unknown	Percent of age class			
				0.5	0.4	0.3	0.2
Gisasa River	24,820	704	124	2	29	68	1
Henshaw Creek	21,400	696	86	5	8	85	2

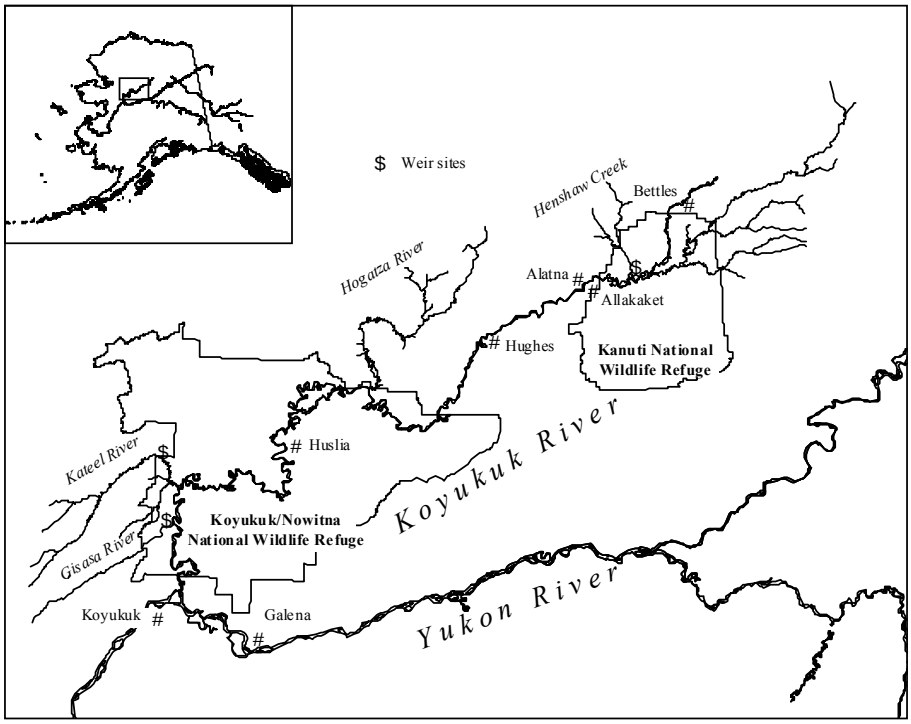

Figure 1.—The Koyukuk River, major tributaries, and resistance board weir study sites, Alaska, 2003.

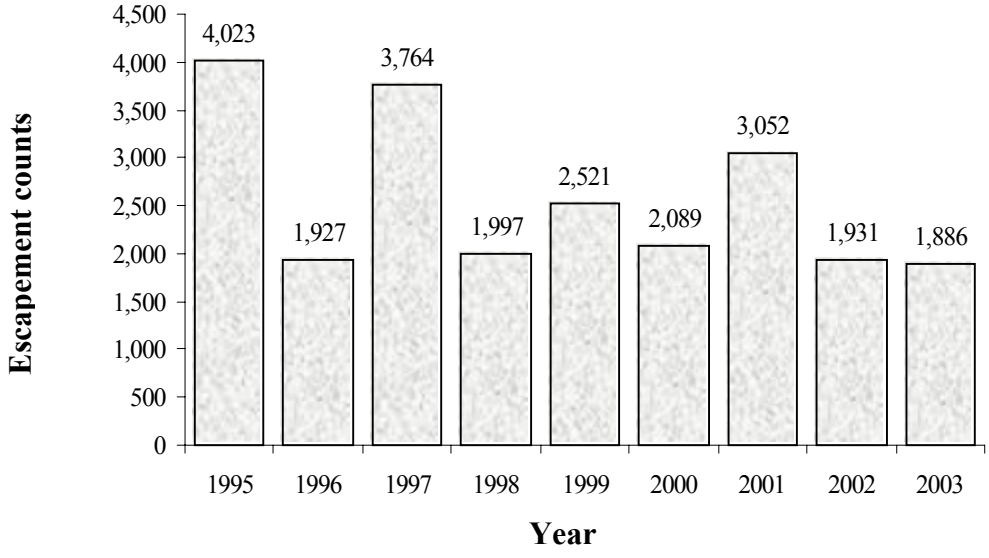

Figure 2.—Historic Chinook salmon escapement counts recorded at Gisasa River weir, Alaska, 1995-2003.

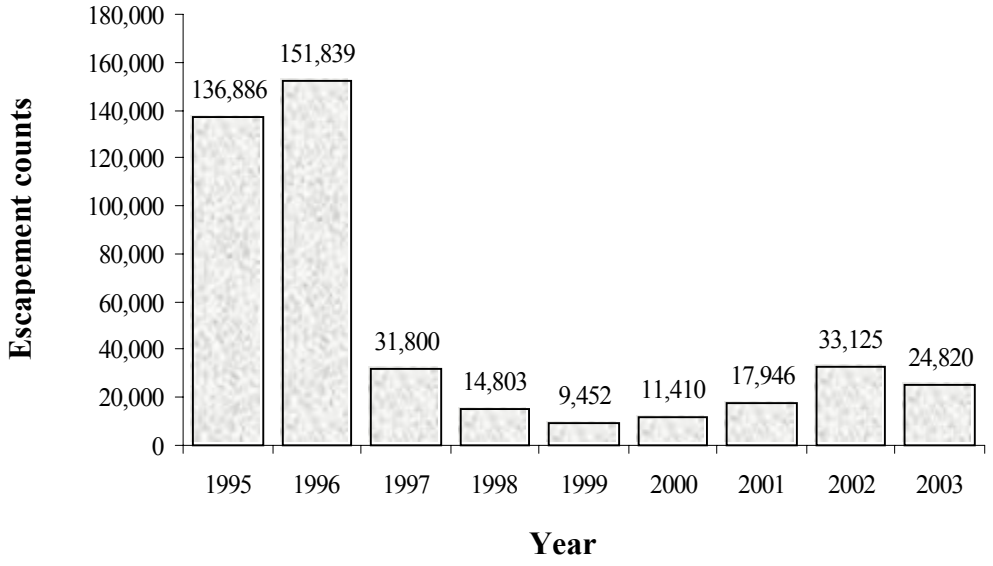

Figure 3.—Historic summer chum salmon escapement counts recorded at Gisasa River weir, Alaska, 1995-2003.

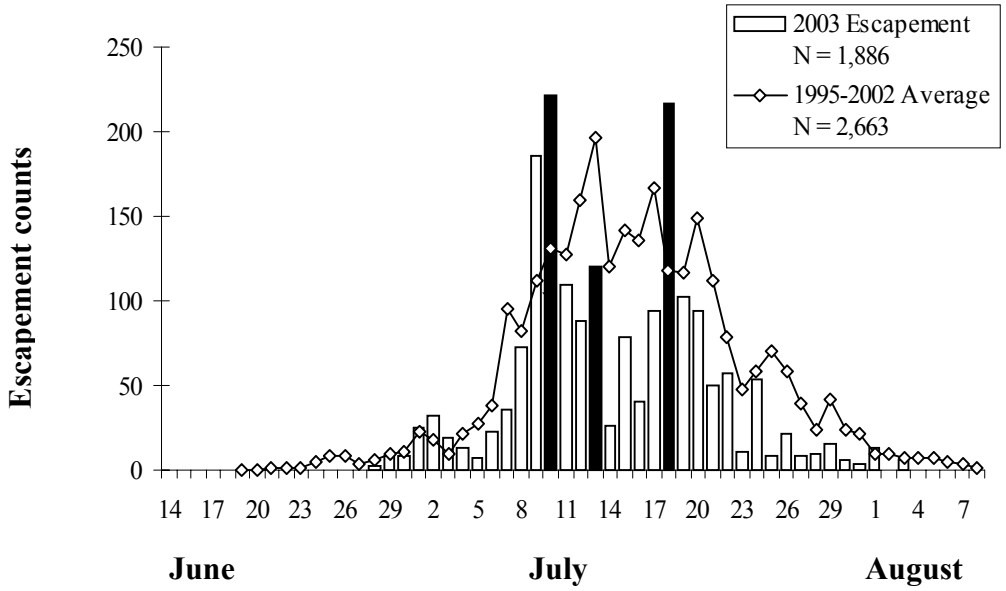

Figure 4.—Daily escapement counts of Chinook salmon recorded at Gisasa River weir, Alaska, 2003, with average daily counts from 1995-2002. Shaded areas represent first, middle, and third quartile of run.

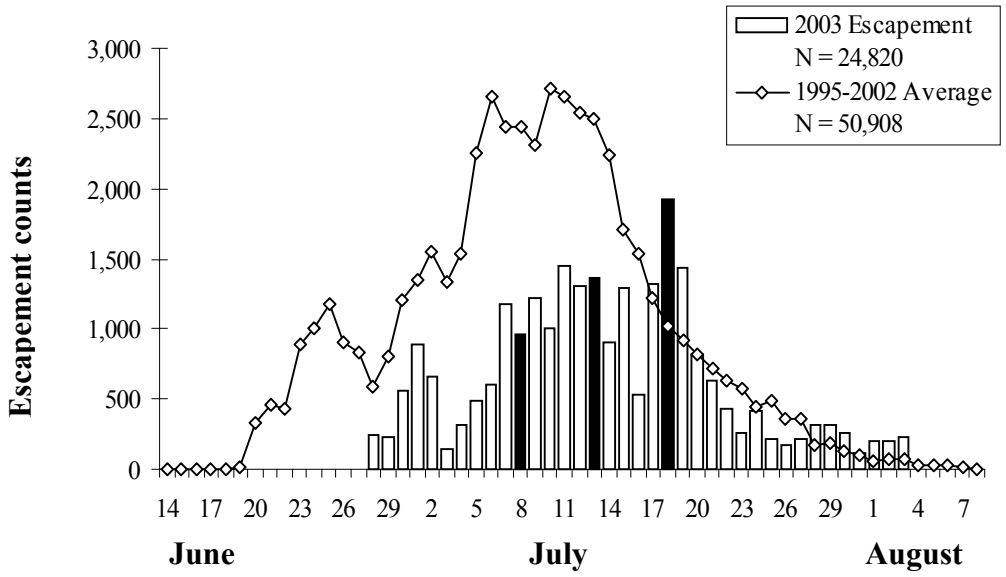

Figure 5.—Daily escapement counts of summer chum salmon recorded at Gisasa River weir, Alaska, 2003, with average daily counts from 1995-2002. Shaded areas represent first, middle, and third quartile of run.

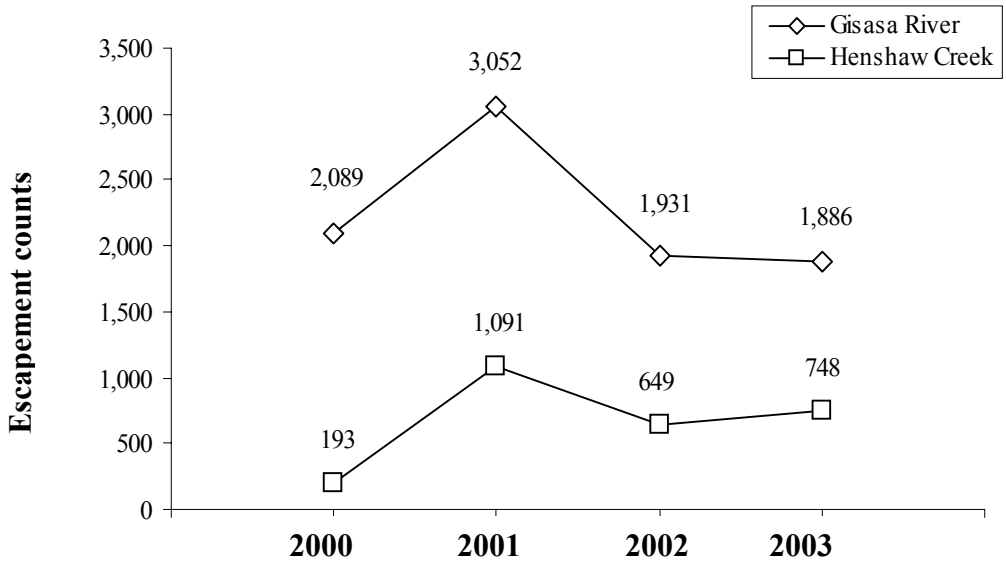

Figure 6.—Seasonal Chinook salmon escapement counts recorded at Gisasa River and Henshaw Creek weirs, Alaska, 2000-2003.

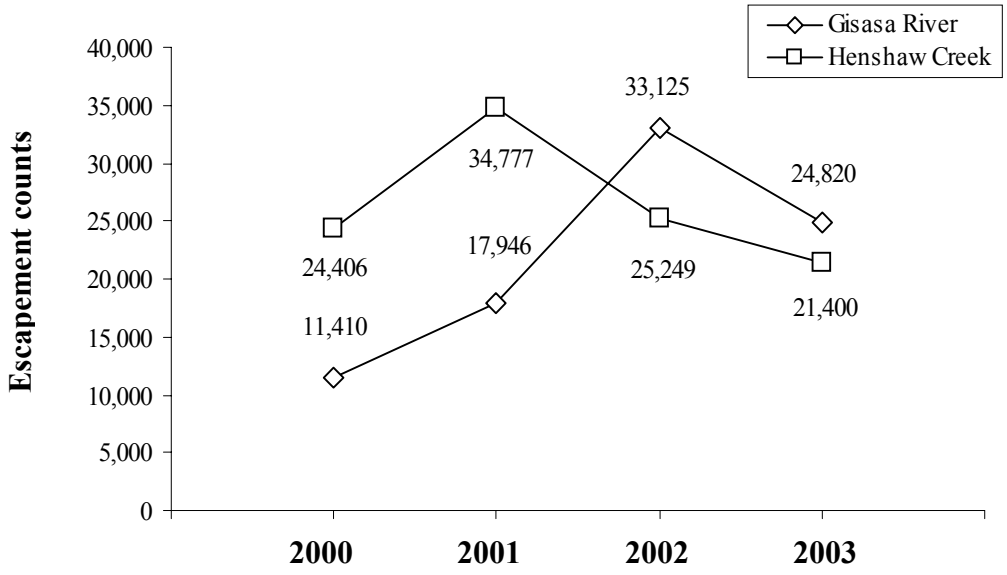

Figure 7.—Seasonal summer chum salmon escapement counts recorded at Gisasa River and Henshaw Creek weirs, Alaska, 2000-2003.

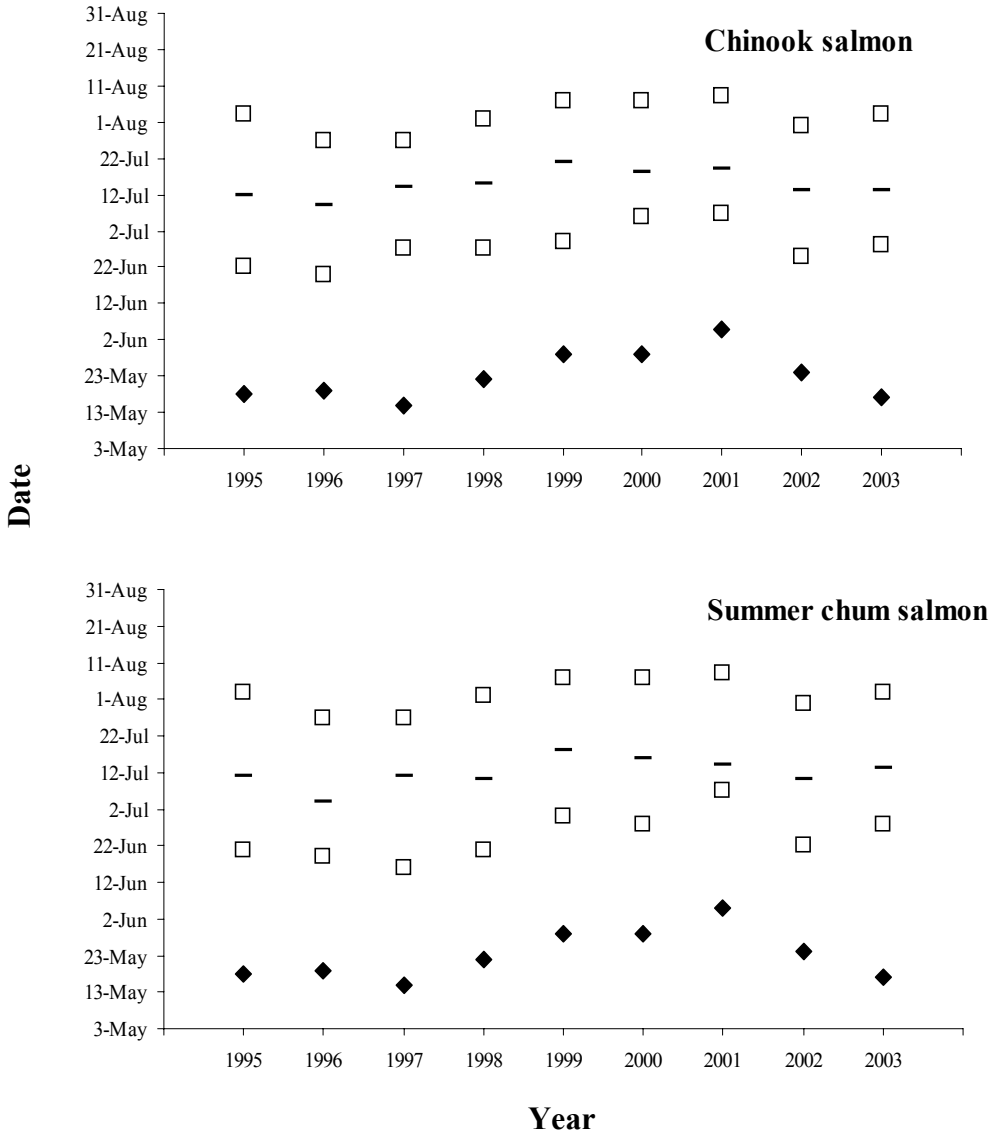

Figure 8.—Run timing distribution of Chinook and summer chum salmon sampled at Gisasa River weir, Alaska, 1995-2003. □ indicates when the first and last Chinook and summer chum salmon were recorded at Gisasa River weir. ─ indicates median quartile. ♦ indicates ice-out on lower Yukon River.

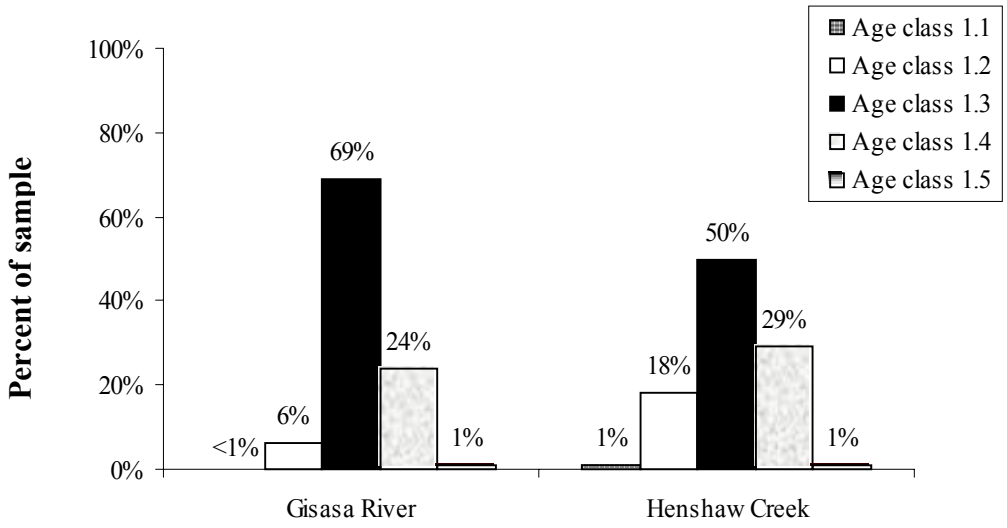

Figure 9.—Age class distribution of Chinook salmon at Gisasa River and Henshaw Creek weirs, Alaska, 2003. Percentages are calculated from weighted weekly totals.

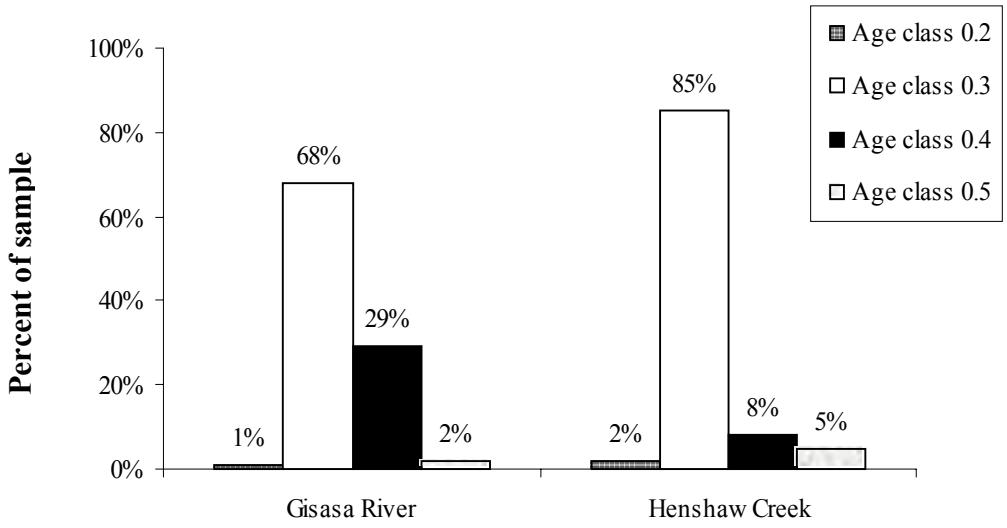

Figure 10.—Age class distribution of summer chum salmon at Gisasa River and Henshaw Creek weirs, Alaska, 2003. Percentages are calculated from weighted weekly totals.

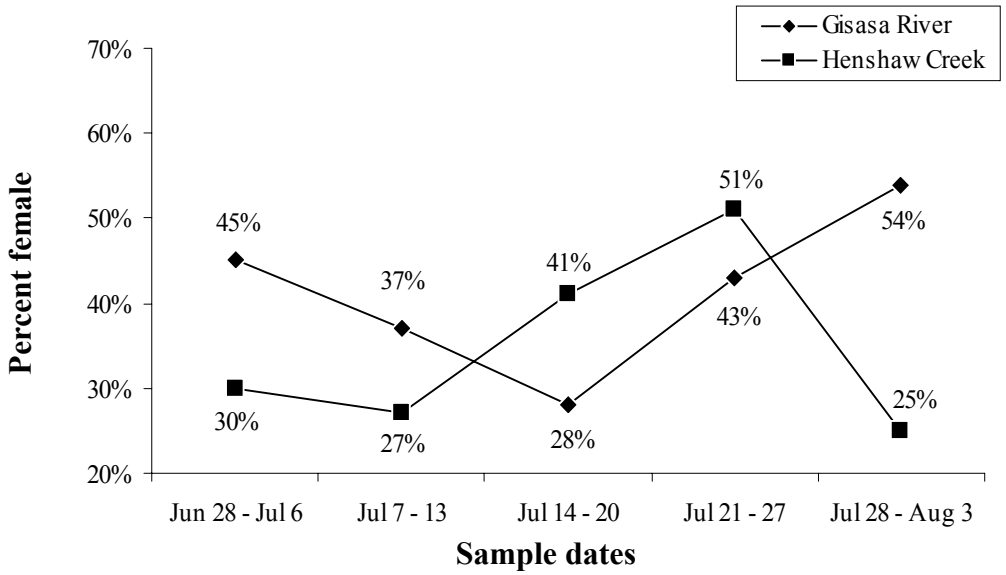

Figure 11.—Average weekly percent females of Chinook salmon recorded at Gisasa River and Henshaw Creek weirs, Alaska, 2003.

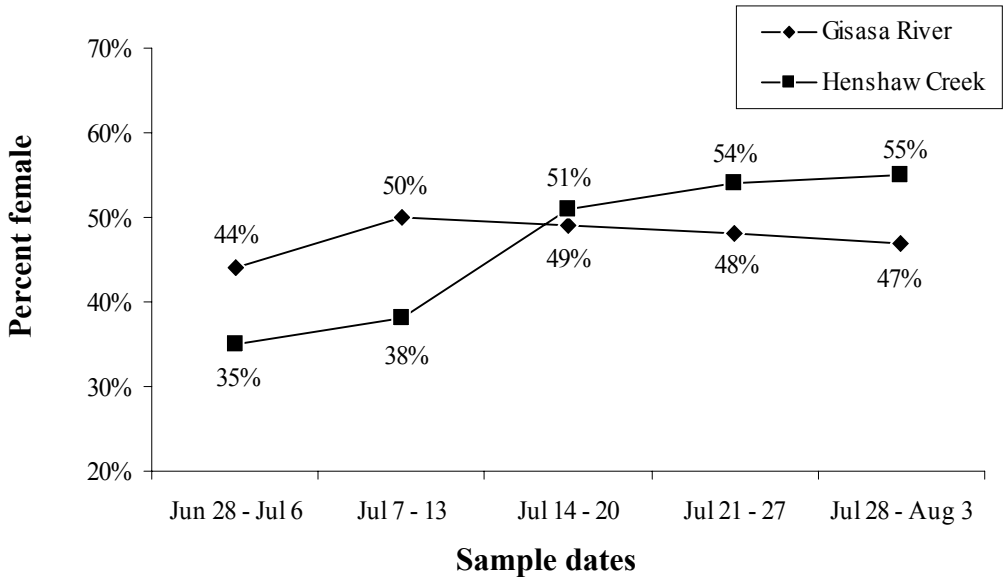

Figure 12.—Average weekly percent females of summer chum salmon recorded at Gisasa River and Henshaw Creek weirs, Alaska, 2003.

Appendix 1.—Historical Chinook and summer chum salmon escapements in Gisasa River, Alaska, 1960-2003. All data except weir estimates are form Barton (1984) and ADF&G, unpublished data. Aerial index estimates are surveys that are rated as poor, fair, or good. Ratings are based on a combination of various environmental conditions such as wind, weather, water, visibility, bottom, time, distance surveyed, and spawning time. Years with no data are not included. * indicates partial counts due to late weir installation.

	Aerial index estimates			Weir estimates	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon
1960	300	400	Good		
1961	266	0	Good		
1974	161	22,022	Good		
1975	385	56,904	Good		
1976	332	21,342	Good		
1977	255	2,204	Good		
1978	45	9,280	Good		
1979	484	10,962	Good		
1980	951	10,388	Good		
1982	421	334	Good		
1983	572	2,356	Good		
1985	735	13,232	Good		
1986	1,346	12,114	Good		
1987	731	2,123	Good		
1988	797	9,284	Good		
1990	884	450	Good		
1991	1,690	7,003	Good		
1992	910	9,300	Good		
1993	1,573	1,581	Good		
1994	2,775	6,827	Good	*2,888	*51,116
1995	410	6,458	Good	4,023	136,886
1996				1,927	151,839
1997	144	686	Good	3,764	31,800
1998	889		Poor	1,997	14,803
1999				2,521	9,452
2000				2,089	11,410
2001				3,052	17,946
2002				1,931	33,125
2003				1,886	24,820