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Abundance and Run Timing of Adult Salmon in Three Tributaries of the Koyukuk River, Alaska, 2002

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Abstract

During 2002, resistance board weirs were used to record escapement information from Chinook *Oncorhynchus tshawytscha* and summer chum *O. keta* salmon in three tributaries within the Koyukuk River drainage, Alaska: Gisasa River; Kateel River; and Henshaw Creek. Annual escapement counts were 2,025 Chinook and 33,481 chum salmon for Gisasa River, 73 Chinook and 2,853 chum salmon for Kateel River, and 649 Chinook and 25,249 chum salmon for Henshaw Creek. Additional biological information was collected on age, sex, and length of each spawning population. Passage information was also recorded for longnose sucker *Catostomus catostomus*, northern pike *Esox lucius*, Arctic grayling *Thymallus arcticus*, and whitefish (Coregoninae). Chinook and summer chum salmon escapement counts from these three tributaries assist fisheries managers in making in-season decisions during the Yukon River commercial and subsistence fishing season, provide post-season evaluation of various management practices, and assist in developing future run projections. Due to the complexity of the mixed-stock Yukon River fishery and the difficulty in managing specific stocks, it is essential to continue collecting information from individual salmon populations, including stocks from the Koyukuk River drainage. It is recommended that the Gisasa River (lower Koyukuk River) and Henshaw Creek projects (upper Koyukuk River) be continued for the long term, so population trends can be analyzed over an extended time-series. Tributary streams containing small salmon stocks, like the Kateel River, should be monitored on a periodic basis.

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 were genetically distinct and differed in life history and phenotypic characteristics, i.e. run timing, spawning locations, and morphology. Chinook and summer chum salmon enter the Yukon River in late May and continue through mid-July (Wiswar 2000). The fall chum salmon run 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 mainly in the upper portions of the Yukon River drainage.

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Recent declines in Yukon River salmon runs, particularly summer and fall chum salmon have led to harvest restrictions, complete fishery closures, and spawning escapements below management goals on many tributaries (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 of multi-species salmon runs, the increasing efficiency of the fishing fleet, allocation issues, and the immense size of the Yukon River drainage. In an attempt to understand this mixed-stock salmon fishery, several studies are being conducted along the main stem and tributaries of the Yukon River to provide managers with information required to assess in-season Chinook and chum salmon escapements (Vania and Golembeski 2000).

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 1993a,b). In the Koyukuk River drainage (a middle Yukon River tributary), Chinook and summer chum salmon utilize tributaries that run through National Wildlife Refuge boundaries. 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, 818 km upriver from the mouth. 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.

Historically, escapement information from Koyukuk River 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, such as counting towers, floating weirs, and riverine hydroacoustics. 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 (VanHatten 2002), in Henshaw Creek since 2000 (VanHatten 2002), and in the South Fork Koyukuk River from 1996 to 1997 (Wiswar 1997, 1998a). The South Fork Koyukuk River weir study was discontinued in 1997 due to persistent high water conditions. A counting tower has been operated by BLM in Clear Creek, a tributary of the Hogatza River, since 1995 (VanHatten 1999; C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication). In addition, a 3-year weir project was initiated in 2001 in the Kateel River by USFWS-FFWFO (VanHatten 2002).

This report describes the 2002 USFWS-FFWFO weir escapement projects conducted in the Gisasa River, Kateel River, and Henshaw Creek. The objectives of each project were to (1)

determine daily escapement and run timing of adult salmon, (2) gather age, sex, and size composition data from passing adult salmon, and (3) monitor non-salmon species movement through the weir.

Gisasa River

Historical data on Chinook and summer chum salmon in the Gisasa River include aerial survey counts collected from 1960 to 1998 (Barton 1984; Schultz et al. 1993; Vania et al. 2002; Appendix 1). Chinook salmon estimates from aerial surveys ranged from 45 fish in 1978 to 2,775 fish in 1994. Summer chum salmon aerial survey estimates ranged from 334 fish in 1982 to 56,904 fish in 1975. Escapement estimates from a resistance board weir were collected from 1994 to 2001 (Melegari and Wiswar 1995; Melegari 1996, 1997; Wiswar 1998b, 1999, 2000, 2001; VanHatten 2002). Annual weir counts for Chinook salmon ranged from 1,991 fish in 1996 to 4,023 fish in 1995 (Appendix 1). Summer chum salmon weir escapements ranged from 10,155 fish in 1999 to 158,752 fish in 1996.

Kateel River

Presence of Chinook and summer chum salmon have been documented in the Kateel River from intermittent aerial surveys conducted between 1974 and 1992 (Barton 1984; Schultz et al. 1993; Appendix 2). Annual Chinook salmon aerial counts ranged from eight fish in 1976 to 185 fish in 1990 and summer chum salmon counts ranged from 238 fish in 1976 to 8,552 fish in 1975.

Henshaw Creek

Historically from 1969 to 1998, aerial survey counts of Chinook salmon ranged from six fish in 1969 to 561 fish in 1986 and summer chum salmon counts ranged from 12 fish in 1982 to 24,780 fish in 1996 (Barton 1984; Schultz et al. 1993; Vania et al. 2002; Appendix 3). A counting tower was operated on Henshaw Creek in 1999. However, due to high water conditions during a three-week period, only a partial count of 12 Chinook and 1,510 summer chum salmon was obtained (VanHatten 1999). In 2000 and 2001, a resistance board weir was installed and operated by USFWS-FFWFO during the full season. The weir counted 193 Chinook and 24,406 summer chum salmon in 2000, and 1,091 Chinook and 34,777 summer chum salmon in 2001 (VanHatten 2002).

Study Area

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

Gisasa River

The Gisasa River is located on the lower Koyukuk River, 90 km upriver from the mouth of the Koyukuk River (Figure 1). The headwaters of the Gisasa River 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 gravel, 25-50 mm diameter).

Kateel River

The Kateel River is located on the Koyukuk River, 122 km upriver from the mouth of the Koyukuk River (Figure 1). The headwaters of the Kateel River originate in the Nulato Hills and the river flows 200 km northeast, passing through the Koyukuk Refuge, before draining into the Koyukuk River (65 ^{o} 32' N latitude, 157 ^{o} 45' W longitude, USGS 1:63,360 series, Kateel River B-4 quadrangle). The location of the weir site is approximately 47 km upriver from the mouth of the Kateel River. This site was selected for its optimal width (31 m), depth (0.6 m), and substrate composition (small cobble, 50-150 mm diameter).

Henshaw Creek

Henshaw Creek is located on the upper Koyukuk River, 753 km upriver from the mouth of the Koyukuk River (Figure 1). The headwaters of Henshaw Creek originate in the Alatna Hills and the river flows 144 km southeast, passing through the Kanuti Refuge, before entering the Koyukuk River (66 ^{o} 33' N latitude, 152 ^{o} 13' W longitude, USGS 1:63,360 series, Bettles C-5 quadrangle). The location of the weir site is approximately 1.5 km upriver from the mouth of Henshaw Creek. This site was selected for its optimal width (29 m), depth (0.6 m), and substrate composition (small cobble, 50-150 mm diameter).

Methods

Weir Operation

Resistance board weirs were used to collect escapement counts and biological information from adult salmon as they migrated into the three study tributaries to spawn. The start date of each project was based on previous years' run timing data. The end date of each project was determined in-season; when the daily count of each species dropped to less than 1% of the seasonal passage to date and continued at this low level for two or more consecutive days. Construction and installation of resistance board weirs were described by Tobin (1994). Each picket of the weir was made of schedule-40, polyvinyl chloride (PVC) electrical conduit with 2.5 cm inside diameter and individual pickets spaced 3.2 cm apart, gap between pickets (Wiswar 2001). During daily visual inspection, the weir was cleaned of debris, fish carcasses, and gravel dislodged by spawning fish. A live trap installed near mid-channel allowed salmon and resident fish species to be recorded as they passed through the weir.

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 passing through the weir each day. Because non-salmon species were not handled, it was difficult to identify different whitefish to species. Therefore, all whitefish were grouped under the subfamily Coregoninae.

The daily counting schedule was dependent upon the level of fish passage through the weir. During the beginning and end of the run, when hourly counts were low, counting was conducted between 0800 and 2400 hours, with the trap closed from 2400 to 0800 hours to prevent upstream

passage during unmonitored times. As the run increased in strength, the counting schedule increased to 24 hours a day, 7 days a week. On the Kateel River, the counting schedule remained between 0800 and 2400 hours for the entire season due to low daily passage. The 16-hour schedule was divided into two 8-hour periods with two crewmembers assigned to each period. The 24-hour schedule was divided into four 6-hour periods with one crewmember assigned to each period and an additional crewmember assisted during biological sampling.

A stratified random sampling scheme was used to collect age, length, and sex ratio information from both adult salmon species. Sampling started at the beginning of each week and generally was conducted over a 3-4 day period, targeting 160 salmon/species/week. 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. Lengths of Chinook and summer chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL). Sex ratio data were collected during age and length sampling. Sex of each fish was visually determined by secondary sex characteristics. Daily escapement counts and sex ratios were reported to USFWS-FFWO in Fairbanks.

Data Analysis

When daily counts were missed due to high water, the missing daily counts were estimated by linear interpolation between the daily count before and after the high water event. Incomplete 24-h counts due to high water were adjusted for a 24-h period.

Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with statistical weeks as the strata. Each statistical week was defined as beginning on Monday and ending on Sunday. Within a week, the proportion of the samples composed of a given sex or age, $\hat{p}_{ij}$, 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 $\hat{p}_{ij}$ 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 chum salmon of a given sex/age, $\hat{p}_i$ were calculated as

$$\hat{p}_i = \sum_{j-1} \hat{W}_j \hat{p}_{ij,}$$

where the stratum weight $\hat{W}_j$ was calculated as

$$\hat{W}_j = \frac{N_j}{N},$$

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. Variance, $\hat{v}(\hat{p}_i)$ of sex and age compositions for the run was calculated as

$$\hat{v}(\hat{p}_i) = \sum_{j-1} \hat{W}_j^2 \hat{v}(\hat{p}_{ij}).$$

Results

Weir Operation

In 2002, all three weirs performed well and were effective in both passing fish and collecting biological information. The spacing between each weir picket (3.2 cm) was close enough to prevent adult Chinook and summer chum salmon from passing through the weir panels. However, small individuals of some non-salmon species, such as Arctic grayling *Thymallus arcticus*, longnose sucker *Catostomus catostomus,* northern pike *Esox lucius*, and whitefish (Coregoninae), likely passed undetected through the weir. Rain events during the 2002 season raised the water levels in all three tributaries. High water levels can jeopardize a weir's integrity, submerging weir panels and causing fish to migrate over and around the weir (Tobin 1994). The Gisasa weir site experienced high enough water levels toward the end of the season to shut the project down for two days. The Kateel River project ended early because of high water. Since the majority of salmon had passed through the two weirs by these dates, annual escapement estimates were not compromised.

Biological Data

Gisasa River—The weir was installed on June 22 and operated until July 31. July 28 and 29 were missed due to high water. There were an estimated 2,025 Chinook salmon, 33,481 summer chum salmon, and 90 non-salmon fish passing through the weir in 2002 (Table 1). The most abundant non-salmon species was longnose sucker (N=61), followed by Arctic grayling (N=26), northern pike (N=2), and whitefish (N=1).

The first Chinook salmon arrived on June 26 and on the last day of operation, July 31, nine Chinook salmon were counted (Table 1). The first quartile migrated through the weir by July 10 and the median migration date was July 13 (Figure 2). There were 570 Chinook salmon sampled for age composition with 44 (8%) samples classified as unknown (Table 2). Age composition of sampled Chinook salmon included four age groups: age 1.2 (32%), age 1.3 (42%), age 1.4 (23%), and age 1.5 (3%). The Chinook salmon sex composition consisted of 21% females (Table 3), representing a stratified seasonal estimate of 397 female fish. The age distribution by sex was unevenly divided among age classes with age 1.4 dominating for females (67%) and ages 1.2 (40%) and 1.3 (48%) dominating for males (Table 4). The average female Chinook salmon length was 812 mm with a range from 620 to 930 mm MEL (Table 5). The average male Chinook salmon length was 625 mm with a range from 420 to 920 mm MEL.

Nineteen summer chum salmon were counted on June 22 (first day of operation) and 75 chum salmon were counted on the last day of operation, July 31 (Table 1). The first quartile migrated through the weir by July 6 and the median migration date was July 10 (Figure 3). There were 883 summer chum salmon sampled for age composition with 106 (12%) samples classified as unknown (Table 6). Age composition of sampled summer chum salmon consisted of four age groups: age 0.2 (1%), age 0.3 (60%), age 0.4 (37%), and age 0.5 (3%). The summer chum salmon sex composition consisted of 48% females (Table 7), representing a stratified seasonal estimate of 15,994 female fish. The age distribution by sex was unevenly divided among age classes with age 0.3 dominating for females (69%) and ages 0.3 (52%) and 0.4 (45%) dominating for males (Table 8). The average female summer chum salmon length was 540 mm with a range from 490 to 625 mm MEL (Table 5). The average male summer chum salmon length was 571 mm with a range from 495 to 660 mm MEL.

Kateel River—The weir was installed on June 23 and operated through July 27. There were no missed daily counts during the season, though a combination of low salmon counts and high water levels shortened the season slightly. There were 73 Chinook salmon, 2,853 summer chum salmon, and 26 non-salmon fish counted as they passed through the weir (Table 9). The most abundant non-salmon species was whitefish (N=13), followed by longnose sucker (N=6), Arctic grayling (N=4), and northern pike (N=3).

The first Chinook salmon arrived on July 5 and the last Chinook salmon was counted on July 25 (Table 9). The first quartile migrated through the weir by July 10 and the median migration date was July 12 (Figure 2). There were 69 Chinook salmon sampled for age composition with three (4%) classified as unknown (Table 10). Age composition of sampled Chinook salmon included three age groups: age 1.2 (50%), age 1.3 (36%), and age 1.4 (14%). The Chinook salmon sex composition consisted of 29% females (Table 11), representing a stratified seasonal estimate of 21 female fish. The age distribution by sex was unevenly divided among the three age classes with age 1.3 dominating for females (47%) and age 1.2 dominating for males (62%; Table 12). The average female Chinook salmon length was 710 mm with a range from 515 to 865 mm MEL (Table 13). The average male Chinook salmon length was 596 mm with a range from 410 to 845 mm MEL.

The first summer chum salmon arrived on June 26 and on the last day of operation, July 27, 16 summer chum salmon were counted (Table 9). The first quartile migrated through the weir by July 9 and the median migration date was July 11 (Figure 3). There were 590 summer chum salmon sampled for age composition with 66 (11%) classified as unknown (Table 14). Age composition of sampled summer chum salmon consisted of three age groups: age 0.3 (58%), age 0.4 (38%), and age 0.5 (4%). The summer chum salmon sex composition consisted of 45% females (Table 15), representing a stratified seasonal estimate of 1,093 female fish. The age distribution by sex was unevenly divided among the three age groups with age 0.3 dominating both females (61%) and males (56%; Table 16). The average female summer chum salmon length was 555 mm with a range from 380 to 650 mm MEL (Table 13). The average male summer chum salmon length was 587 mm with a range from 450 to 670 mm MEL.

Henshaw River—The weir was installed on June 22 and operated through August 2. There were no missed daily counts during the season. A total of 649 Chinook salmon, 25,249 summer chum salmon, and 3,276 non-salmon fish were counted as they passed through the weir (Table 17). The

most abundant non-salmon species was longnose sucker (N=3,125), followed by Arctic grayling (N=142), whitefish (N=8), and northern pike (N=1).

The first Chinook salmon arrived on July 1 and on the last day of operation, August 2, one Chinook salmon was counted (Table 17). The first quartile migrated through the weir by July 10 and the median migration date was July 14 (Figure 2). There were 386 Chinook salmon sampled for age composition with 39 (10%) of the samples classified as unknown (Table 18). Age composition of sampled Chinook salmon included four age groups: age 1.2 (30%), age 1.3 (36%), age 1.4 (31%), and age 1.5 (2%). The Chinook salmon sex composition consisted of 31% females (Table 19), representing a stratified seasonal estimate of 195 female fish. The age distribution by sex was unevenly divided among the four age groups with age 1.4 dominating the females (70%) and ages 1.2 (43%) and 1.3 (42%) dominating the males (Table 20). The average female Chinook salmon length was 818 mm with a range from 540 to 975 mm MEL (Table 21). The average male Chinook salmon length was 637 mm with a range from 410 to 950 mm MEL.

The first summer chum salmon arrived on June 29 and on the last day of operation, August 2, 76 chum salmon were counted (Table 17). The first quartile migrated through the weir by July 10 and the median migration date was July 15 (Figure 3). There were 874 summer chum salmon sampled for age composition with 142 (16%) of the sample classified as unknown (Table 22). Age composition of sampled summer chum salmon consisted of four age groups: age 0.2 (<1%), age 0.3 (16%), age 0.4 (80%), and age 0.5 (4%). The summer chum salmon sex composition consisted of 60% females (Table 23), representing a stratified seasonal estimate of 15,601 female fish. The age distribution by sex was unevenly divided among the four age groups with age 0.4 dominating both females (79%) and males (83%; Table 24). The average female summer chum salmon length was 556 mm with a range from 450 to 635 mm MEL (Table 21). The average male summer chum salmon length was 592 mm with a range from 515 to 805 mm MEL.

Discussion

Escapement and Run timing

In 2002, the run size of Chinook salmon varied considerably among the three drainages, with the Gisasa River having the highest escapement of 2,025 Chinook salmon, followed by Henshaw Creek with 649, and Kateel River with 73. According to the United States/Canada Yukon River Joint Technical Committee (JTC 2002), Yukon River tributary escapement projects for Chinook salmon in 2002 showed a decrease in numbers from 2001 counts. This trend was also apparent on the Gisasa River and Henshaw Creek (Figures 4 and 5). The 2002 season was the first year data have been collected from the Kateel River and therefore comparisons cannot be made with past years.

Similar to the Chinook salmon run, summer chum salmon abundance in 2002 varied substantially among the three drainages, with the Gisasa River having the highest escapement of 33,481 summer chum salmon, followed by Henshaw Creek with 25,249, and Kateel River with 2,853. In general, Yukon River summer chum stocks have experienced a slight increase in size from the run failures of 1998 through 2000 (JTC 2002). This trend is also apparent on the Gisasa River where escapement numbers have more than tripled in 2002 from the lowest recorded escapement of 10,155 fish in 1999 (Figure 4). The 2002 count is still well below the high escapement numbers from 1995 and 1996 of 136,886 and 158,752 fish, respectively.

Unfortunately, longer time-series on Henshaw Creek and Kateel River are needed before historical comparisons can be made.

Assuming similar swim speeds and mixing of Koyukuk River salmon stocks, it would be expected that fish entering Henshaw Creek (upper tributary) would be further separated in run timing from lower tributary stocks than the data suggest. Chinook and chum salmon run timing was similar between the three Koyukuk River tributaries (Figures 2 and 3), even though the study sites have a wide geographic separation (over 660 river km separate the Gisasa River and Henshaw Creek). Median passage dates for Chinook salmon were separated by only one day between the Gisasa River and Henshaw Creek and chum salmon median passage dates were only 5 days apart. Telemetry studies in the main stem Yukon River suggest that Chinook salmon bound for Koyukuk River tributaries travel between 43 and 58 km/day (Eiler et al. 2004), with chum salmon traveling somewhat slower than Chinook salmon (J. Eiler, NOAA, personal communication). Given these estimated swim speeds, it should take an additional 11 or more days for salmon to reach Henshaw Creek after passing the Gisasa River confluence. The similar migration timing among the three Koyukuk River salmon stocks may be related to: 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 fish going farther swim faster; and/or 3) milling time may be inversely proportional to the distance salmon need to travel to their spawning grounds (Molyneaux et al. 1997). Specific Koyukuk River telemetry studies are needed to specifically address run timing patterns among the three tributaries.

Age Distribution

In general, Chinook salmon populations are made up of six age classes, with age 1.4 fish dominating (Groot and Margolis 1998). Chinook salmon populations from the three Koyukuk River tributaries consisted of between three and four age classes, with the most common being age 1.3 in Gisasa River (42%), age 1.2 in Kateel River (50%), and ages 1.2 (30%), 1.3 (36%), and 1.4 (31%) in Henshaw Creek (Table 25).

In North America, chum salmon populations generally are comprised of four age classes, with age 0.3 fish dominating (Groot and Margolis 1998). Summer chum salmon populations from the three Koyukuk River tributaries consisted of between three and four age classes, with the most common being age 0.3 in Gisasa (60%) and Kateel (58%) rivers, and age 0.4 in Henshaw Creek (80%; Table 26).

Using scales to age salmon may give a biased estimation of age when the samples are taken close to spawning grounds. Age analysis studies, comparing scale and vertebrae sampling, showed that ageing salmon by scales could underestimate age (Wiswar 1997, 1998b). 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 of chum salmon conducted in the South Fork Koyukuk River reported ages from scales were lower than readings from vertebrae (Wiswar 1997). This study collected samples from two different time periods with the first sampling period having only a 44% agreement between scale and vertebrae ageing structures and the second period having a 79% agreement. An additional study on chum salmon was conducted in the Gisasa River (Wiswar 1998b). This study showed that the scale and vertebrae ageing were in 73% agreement and the scale readings were biased low. It is recommended that stream specific studies be

initiated to determine if scale samples give an unbiased estimator of age in Chinook and summer chum salmon.

Sex Ratio

A high proportion of females on the spawning ground is indicative of the general health and productivity of a salmon population (Groot and Margolis 1998). The proportions of female Chinook salmon were low on all three Koyukuk River tributaries in 2002, with annual percentages varying from 21% female in the Gisasa River, 29% in the Kateel River, and 31% in Henshaw Creek. The summer chum salmon populations showed a higher percentage of females than Chinook salmon, varying from 45% female in the Kateel River, 48% in the Gisasa River, and 60% in Henshaw Creek.

Conclusion

Due to the complexity of the Yukon River mixed-stock salmon fishery and the difficulty in managing specific stocks, it is vital to continue collecting information from individual salmon populations, including stocks in the Koyukuk River drainage. It is recommended that the Gisasa River (lower Koyukuk River) and Henshaw Creek (upper Koyukuk River) be continued for long-term status and trend monitoring, so population changes can be documented over a long time-series. Small stocks, such as the Chinook and chum salmon stocks on the Kateel River can be susceptible to over-harvest in a mixed-stock fishery. It is recommended that Kateel River salmon be monitored on a periodic basis, to ensure that these populations remain healthy.

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Table 1. Daily and cumulative (Chinook and summer chum salmon only) count of fish passing through Gisasa River weir, Alaska, 2002. (Cum = cumulative).

	Chinook salmon		Summer chum salmon		Longnose sucker	Arctic grayling	Northern pike	Whitefish spp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
22-Jun	0	0	19	19	0	0	0	0
23-Jun	0	0	3	22	0	0	0	0
24-Jun	0	0	68	90	0	0	0	0
25-Jun	0	0	150	240	1	0	0	0
26-Jun	1	1	128	368	3	2	0	0
27-Jun	0	1	228	596	4	0	0	0
28-Jun	3	4	356	952	5	0	0	0
29-Jun	0	4	570	1,522	5	0	0	0
30-Jun	4	8	1,331	2,853	7	0	0	0
1-Jul	5	13	1,116	3,969	6	0	0	0
2-Jul	5	18	803	4,772	2	0	0	0
3-Jul	9	27	833	5,605	0	0	0	0
4-Jul	0	27	430	6,035	1	0	0	0
5-Jul	15	42	1,059	7,094	0	0	0	0
6-Jul	41	83	1,765	8,859	0	0	0	0
7-Jul	134	217	2,293	11,152	0	0	0	0
8-Jul	103	320	2,122	13,274	0	0	0	0
9-Jul	135	455	1,879	15,153	2	1	0	0
10-Jul	134	589	2,446	17,599	2	0	0	0
11-Jul	100	689	1,493	19,092	4	1	0	0
12-Jul	259	948	1,731	20,823	1	1	0	0
13-Jul	359	1,307	1,898	22,721	3	1	0	0
14-Jul	66	1,373	1,608	24,329	4	0	0	0
15-Jul	78	1,451	1,017	25,346	1	2	0	0
16-Jul	37	1,488	1,225	26,571	2	1	0	0
17-Jul	48	1,536	1,186	27,757	2	4	1	0
18-Jul	23	1,559	1,086	28,843	0	6	0	0
19-Jul	37	1,596	774	29,617	1	4	0	0
20-Jul	63	1,659	728	30,345	0	0	0	0
21-Jul	22	1,681	669	31,014	0	1	0	1
22-Jul	27	1,708	544	31,558	0	0	0	0
23-Jul	16	1,724	377	31,935	0	0	0	0
24-Jul	18	1,742	272	32,207	2	1	0	0
25-Jul	15	1,757	268	32,475	0	1	1	0
26-Jul	73	1,830	315	32,790	1	0	0	0
27-Jul	91	1,921	226	33,016	1	0	0	0
28-Jul	* 61	1,982	* 178	33,016	0	0	0	0
29-Jul	* 32	2,013	* 130	33,016	0	0	0	0
30-Jul	** 2	2,015	** 82	33,050	1	0	0	0
31-Jul	9	2,024	75	33,125	0	0	0	0
Total	2,025		33,481		61	26	2	1

* Adjusted 24-h count from missing day

** Adjusted 24-h count from incomplete day

Table 2. Percent weekly and seasonal age estimates of Chinook salmon sampled at Gisasa River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

				Brood year and age			
				1998	1997	1996	1995
Time period	Run size (N)	Sample size (n)	Unknown	1.2	1.3	1.4	1.5
Jun 22-23	0						
Jun 24-30	8	7	1	29 (18.4)	71 (18.4)	0 (0.0)	0 (0.0)
Jul 1-7	209	166	10	36 (3.7)	46 (3.9)	17 (3.0)	1 (0.6)
Jul 8-14	1,156	65	5	37 (6.0)	40 (6.1)	17 (4.7)	6 (3.0)
Jul 15-21	308	154	13	38 (3.9)	38 (3.9)	23 (3.4)	1 (0.6)
Jul 22-28	301	131	15	18 (3.3)	40 (4.3)	36 (4.2)	7 (2.2)
Jul 29-31	43	3	0	67 (33.3)	33 (33.3)	0 (0.0)	0 (0.0)
Total	2,025	526	44	32 (3.6)	42 (3.7)	23 (289)	3 (1.8)

Table 3. Percent weekly and seasonal female sex contribution of Chinook salmon sampled at Gisasa River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

Time Period	Run size (N)	Sample size (n)	Percent female
Jun 22-23	0		
June 24-30	8	7	29 (18.4)
Jul 1-7	209	166	8 (2.2)
Jul 8-14	1,156	65	17 (4.7)
Jul 15-21	308	154	16 (3.0)
Jul 22-28	301	131	44 (4.3)
Jul 29-31	43	3	0 (0.0)
Total	2,025	526	21 (2.8)

Table 4. Percent seasonal sex contribution by age of Chinook salmon sampled at Gisasa River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

					Brood year and age			
					1998	1997	1996	1995
Sex	Run size (N)	Sample size (n)	Unknown	Seasonal sex percentage	1.2	1.3	1.4	1.5
Female	397	109	12	21	0 (0.0)	19 (7.2)	67 (9.2)	14 (8.8)
Male	1,628	417	32	79	40 (4.1)	48 (4.1)	12 (2.6)	0 (0.0)

Table 5. Length at age of female and male Chinook and summer chum salmon sampled at Gisasa River weir, Alaska, 2002.

	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										
1.2	0					168	529	530	3.2	420-645
1.3	21	736	735	10.7	620-820	199	673	675	4.0	510-875
1.4	73	819	825	5.6	710-920	50	754	745	8.4	670-920
1.5	15	882	880	11.1	810-930	0				
Total	109	812	815	6.1	620-930	417	625	630	4.8	420-920
Summer chum salmon										
0.2	3	517	510	12.0	500-540	2	545	545	30.0	515-575
0.3	257	536	535	1.4	490-600	210	565	560	1.8	500-640
0.4	103	551	550	2.6	495-625	182	576	570	2.0	495-660
0.5	7	563	560	10.0	530-610	13	598	600	7.4	560-650
Total	370	540	540	1.3	490-625	407	571	570	1.4	495-660

Table 6. Percent weekly and seasonal age estimates of summer chum salmon sampled at Gisasa River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

				Brood year and age			
				1999	1998	1997	1996
Time period	Run size (N)	Sample size (n)	Unknown	0.2	0.3	0.4	0.5
Jun 22-23	22	9	1	0 (0.0)	33 (16.7)	44 (17.6)	22 (14.7)
Jun 24-30	2,831	161	33	0 (0.0)	52 (3.9)	43 (3.9)	5 (1.7)
Jul 1-7	8,299	161	17	0 (0.0)	53 (3.9)	43 (3.9)	4 (1.6)
Jul 8-14	13,177	144	13	1 (0.7)	66 (4.0)	33 (3.9)	1 (0.7)
Jul 15-21	6,685	123	15	1 (0.8)	59 (4.5)	40 (4.4)	1 (0.8)
Jul 22-28	2,180	142	19	1 (1.0)	71 (3.8)	27 (3.8)	0 (0.0)
Jul 29-31	287	37	8	3 (2.7)	73 (7.4)	22 (6.9)	3 (2.7)
Total	33,481	777	106	1 (0.3)	60 (2.1)	37 (2.1)	3 (0.5)

Table 7. Percent weekly and seasonal female sex contribution of summer chum salmon sampled at Gisasa River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

Time period	Run size (N)	Sample size (n)	Percent female
Jun 22-23	22	9	33 (16.7)
Jun 24-30	2,831	161	34 (3.7)
Jul 1-7	8,299	161	41 (3.9)
Jul 8-14	13,177	144	48 (4.2)
Jul 15-21	6,685	123	58 (4.5)
Jul 22-28	2,180	142	58 (4.2)
Jul 29-31	287	37	65 (8.0)
Total	33,481	777	48 (2.2)

Table 8. Percent seasonal sex contribution by age of summer chum salmon sampled at Gisasa River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

					Brood year and age			
					1999	1998	1997	1996
Sex	Run size (N)	Sample size (n)	Unknown	Seasonal sex Percentage	0.2	0.3	0.4	0.5
Female	15,994	370	50	48	1 (0.6)	69 (2.8)	28 (2.7)	2 (0.9)
Male	17,487	407	56	52	0 (0.1)	52 (3.0)	45 (3.0)	3 (0.7)

Table 9. Daily and cumulative (Chinook and summer chum salmon only) count of fish passing through Kateel River weir, Alaska, 2002. (Cum = cumulative).

	Chinook salmon		Summer chum salmon		Whitefish spp.	Longnose sucker	Arctic grayling	Northern pike
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
23-Jun	0	0	0	0	0	0	0	0
24-Jun	0	0	0	0	0	0	0	0
25-Jun	0	0	0	0	0	0	0	0
26-Jun	0	0	2	2	0	0	0	0
27-Jun	0	0	1	3	0	0	0	0
28-Jun	0	0	5	8	0	0	0	0
29-Jun	0	0	2	10	0	0	0	0
30-Jun	0	0	2	12	0	0	0	0
1-Jul	0	0	7	19	0	1	0	1
2-Jul	0	0	11	30	0	0	0	0
3-Jul	0	0	8	38	0	0	0	0
4-Jul	0	0	51	89	0	0	0	0
5-Jul	3	3	94	183	2	0	1	0
6-Jul	0	3	58	241	0	0	0	0
7-Jul	2	5	137	378	0	0	0	0
8-Jul	5	10	269	647	1	1	0	1
9-Jul	7	17	296	943	0	0	1	0
10-Jul	5	22	258	1,201	2	1	0	0
11-Jul	10	32	305	1,506	1	0	0	0
12-Jul	7	39	221	1,727	0	0	0	0
13-Jul	4	43	211	1,938	1	2	2	0
14-Jul	4	47	196	2,134	0	0	0	0
15-Jul	3	50	91	2,225	1	0	0	0
16-Jul	0	50	140	2,365	0	0	0	0
17-Jul	4	54	84	2,449	3	1	0	0
18-Jul	3	57	74	2,523	2	0	0	0
19-Jul	2	59	65	2,588	0	0	0	0
20-Jul	1	60	49	2,637	0	0	0	0
21-Jul	5	65	58	2,695	0	0	0	0
22-Jul	4	69	44	2,739	0	0	0	0
23-Jul	1	70	51	2,790	0	0	0	0
24-Jul	2	72	19	2,809	0	0	0	0
25-Jul	1	73	17	2,826	0	0	0	0
26-Jul	0	73	11	2,837	0	0	0	1
27-Jul	0	73	16	2,853	0	0	0	0
Total	73		2,853		13	6	4	3

Table 10. Percent weekly and seasonal age estimates of Chinook salmon sampled at Kateel River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

				Brood year and age		
				1998	1997	1996
Time period	Run size (N)	Sample size (n)	Unknown	1.2	1.3	1.4
Jun 23-30	0					
Jul 1-7	5	5	0	40 (24.5)	60 (24.5)	0 (0.0)
Jul 8-14	42	36	2	50 (8.5)	33 (8.0)	17 (6.3)
Jul 15-21	18	17	1	53 (12.5)	35 (11.9)	12 (8.1)
Jul 22-27	8	8	0	50 (18.9)	38 (18.3)	13 (12.5)
Total	73	66	3	50 (6.3)	36 (6.0)	14 (4.4)

Table 11. Percent weekly and seasonal female sex contribution of Chinook salmon sampled at Kateel River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

Time period	Run size (N)	Sample size (n)	Percent female
Jun 23-30	0		
Jul 1-7	5	5	40 (24.5)
Jul 8-14	42	36	25 (7.3)
Jul 15-21	18	17	35 (11.9)
Jul 22-27	8	8	25 (16.4)
Total	73	66	29 (5.7)

Table 12. Percent seasonal sex contribution by age of Chinook salmon sampled at Kateel River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

					Brood year and age		
					1998	1997	1996
Sex	Run size (N)	Sample size (n)	Unknown	Seasonal sex percentage	1.2	1.3	1.4
Female	21	19	3	29	21 (9.6)	47 (11.8)	32 (11.0)
Male	52	47	0	71	62 (7.2)	32 (6.9)	6 (3.6)

Table 13. Length at age of female and male Chinook and summer chum salmon sampled at Kateel River weir, Alaska, 2002.

	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										
1.2	4	549	550	18.1	515-580	29	539	540	9.1	410-625
1.3	9	695	685	21.9	590-790	15	673	670	12.1	565-730
1.4	6	839	833	7.9	820-865	3	765	740	40.9	710-845
Total	19	710	740	26.9	515-865	47	596	575	13.2	410-845
Summer chum salmon										
0.3	143	549	550	2.2	480-650	160	578	575	2.6	450-665
0.4	86	562	560	3.4	380-625	115	596	600	2.6	530-670
0.5	7	581	590	15.9	520-630	13	618	615	10.2	560-670
Total	236	555	555	1.9	380-650	288	587	585	1.9	450-670

Table 14. Percent weekly and seasonal age estimates of summer chum salmon sampled at Kateel River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

				Brood year and age		
				1998	1997	1996
Time period	Run size (N)	Sample size (n)	Unknown	0.3	0.4	0.5
Jun 23-30	12	10	1	50 (16.7)	50 (16.7)	0 (0.0)
Jul 1-7	366	152	11	53 (4.1)	41 (4.0)	6 (1.9)
Jul 8-14	1,756	137	25	55 (4.3)	41 (4.2)	4 (1.6)
Jul 15-21	561	116	16	65 (4.5)	33 (4.4)	3 (1.5)
Jul 22-27	158	109	13	61 (4.7)	37 (4.6)	3 (1.6)
Total	2,853	524	66	58 (2.8)	38 (2.8)	4 (1.1)

Table 15. Percent weekly and seasonal female sex contribution of summer chum salmon sampled at Kateel River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

Time period	Run size (N)	Sample size (n)	Percent female
Jun 23-30	12	10	50 (16.7)
Jul 1-7	366	152	38 (4.0)
Jul 8-14	1,756	137	30 (3.9)
Jul 15-21	561	116	59 (4.6)
Jul 22-27	158	109	59 (4.7)
Total	2,853	524	45 (2.6)

Table 16. Percent sex contribution by age of summer chum salmon sampled at Kateel River weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

					Brood year and age		
					1998	1997	1996
Sex	Run size (N)	Sample size (n)	Unknown	Seasonal sex percentage	0.3	0.4	0.5
Female	1,093	236	25	45	61 (5.1)	36 (5.1)	3 (0.5)
Male	1,760	288	41	55	56 (3.5)	40 (3.5)	5 (1.5)

Table 17. Daily and cumulative (Chinook and summer chum only) count of fish passing through Henshaw Creek weir, Alaska, 2002. (Cum = cumulative).

	Chinook salmon		Summer chum salmon		Longnose sucker	Arctic grayling	Whitefish spp.	Northern pike
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
22-Jun	0	0	0	0	0	0	0	0
23-Jun	0	0	0	0	0	0	0	0
24-Jun	0	0	0	0	0	0	0	0
25-Jun	0	0	0	0	0	0	0	0
26-Jun	0	0	0	0	0	0	0	0
27-Jun	0	0	0	0	0	0	0	0
28-Jun	0	0	0	0	0	0	0	0
29-Jun	0	0	35	35	30	2	0	0
30-Jun	0	0	22	57	3	10	0	0
1-Jul	1	1	55	112	5	12	0	0
2-Jul	0	1	187	299	5	9	0	0
3-Jul	2	3	237	536	0	13	0	0
4-Jul	0	3	321	857	0	6	0	0
5-Jul	1	4	285	1,142	13	9	2	0
6-Jul	9	13	585	1,727	13	5	0	0
7-Jul	10	23	1,362	3,089	32	7	1	0
8-Jul	29	52	1,380	4,469	51	5	0	0
9-Jul	62	114	1,646	6,115	85	5	0	1
10-Jul	51	165	1,079	7,194	605	6	0	0
11-Jul	65	230	741	7,935	582	2	1	0
12-Jul	64	294	779	8,714	86	0	0	0
13-Jul	30	324	982	9,696	2	0	0	0
14-Jul	58	382	1,480	11,176	0	0	0	0
15-Jul	31	413	1,839	13,015	0	3	0	0
16-Jul	44	457	1,870	14,885	146	2	0	0
17-Jul	37	494	1,796	16,681	297	0	0	0
18-Jul	29	523	1,501	18,182	68	0	0	0
19-Jul	33	556	1,309	19,491	19	4	1	0
20-Jul	20	576	1,055	20,546	0	1	0	0
21-Jul	12	588	879	21,425	2	2	0	0
22-Jul	20	608	567	21,992	81	0	0	0
23-Jul	8	616	547	22,539	31	0	0	0
24-Jul	8	624	585	23,124	85	0	1	0
25-Jul	1	625	384	23,508	191	1	0	0
26-Jul	4	629	233	23,741	59	0	0	0
27-Jul	4	633	377	24,118	24	6	0	0
28-Jul	1	634	338	24,456	78	0	0	0
29-Jul	5	639	302	24,758	427	28	0	0
30-Jul	4	643	135	24,893	50	2	1	0
31-Jul	2	645	174	25,067	51	1	0	0
1-Aug	3	648	106	25,173	4	0	1	0
2-Aug	1	649	76	25,249	0	1	0	0
Total	649		25,249		3,125	142	8	1

Table 18. Percent weekly and seasonal age estimates of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

				Brood year and age			
				1998	1997	1996	1995
Time period	Run size (N)	Sample size (n)	Unknown	1.2	1.3	1.4	1.5
Jun 22-30	0						
Jul 1-7	23	22	1	36 (10.5)	55 (10.9)	9 (6.3)	0 (0.0)
Jul 8-14	359	144	18	28 (3.7)	38 (4.0)	32 (3.9)	3 (1.4)
Jul 15-21	206	134	16	28 (3.9)	36 (4.2)	34 (4.1)	2 (1.3)
Jul 22-28	46	36	2	39 (8.2)	22 (7.0)	39 (8.2)	0 (0.0)
Jul 29-Aug 2	15	11	2	45 (15.7)	27 (14.1)	18 (12.2)	9 (9.1)
Total	649	347	39	30 (2.5)	36 (2.7)	31 (2.6)	2 (0.9)

Table 19. Percent weekly and seasonal female sex contribution of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

Time period	Run size (N)	Sample size (n)	Percent female
Jun 22-30	0		
Jul 1-7	23	22	27 (9.7)
Jul 8-14	359	144	27 (3.7)
Jul 15-21	206	134	34 (4.1)
Jul 22-28	46	36	33 (8.0)
Jul 29-Aug 2	15	11	45 (15.7)
Total	649	347	31 (2.5)

Table 20. Percent seasonal sex contribution by age of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

					Brood year and age			
					1998	1997	1996	1995
Sex	Run size (N)	Sample size (n)	Unknown	Seasonal sex percentage	1.2	1.3	1.4	1.5
Female	195	107	20	31	1 (0.6)	22 (4.1)	70 (4.6)	7 (2.7)
Male	454	240	19	69	43 (3.3)	42 (3.3)	14 (2.4)	0 (0.5)

Table 21. Length at age of Chinook and summer chum salmon sampled at Henshaw Creek weir, Alaska, 2002.

	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										
1.2	1	540	540	--	--	104	521	520	7.2	410-860
1.3	24	784	800	13.4	610-890	101	699	700	6.2	545-930
1.4	75	832	830	6.3	715-975	34	797	788	10.5	685-950
1.5	7	853	865	22.0	740-920	1	895	895	--	--
Total	107	818	830	6.4	540-975	240	637	655	8.1	410-950
Summer chum salmon										
0.2	1	520	520	--	--	0				
0.3	79	543	540	3.5	450-630	35	577	570	5.1	540-690
0.4	348	559	560	1.3	465-635	241	594	590	2.4	515-805
0.5	14	570	570	6.0	540-600	14	589	585	7.6	540-640
Total	442	556	560	1.3	450-635	290	592	590	2.1	515-805

Table 22. Percent weekly and seasonal age estimates of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

				Brood year and age			
				1999	1998	1997	1996
Time period	Run size (N)	Sample size (n)	Unknown	0.2	0.3	0.4	0.5
Jun 22-30	57	37	20	0 (0.0)	8 (4.5)	92 (4.5)	0 (0.0)
Jul 1-7	3,032	147	27	0 (0.0)	9 (2.3)	86 (2.8)	5 (1.8)
Jul 8-14	8,087	138	28	0 (0.0)	12 (2.7)	81 (3.3)	7 (2.2)
Jul 15-21	10,249	129	21	0 (0.0)	17 (3.3)	82 (3.4)	1 (0.8)
Jul 22-28	3,031	145	20	1 (0.7)	19 (3.3)	76 (3.6)	4 (1.7)
Jul 29-Aug 2	793	136	26	0 (0.0)	24 (3.7)	74 (3.8)	3 (1.5)
Total	25,249	732	142	0 (0.1)	16 (1.7)	80 (1.8)	4 (0.8)

Table 23. Percent weekly and seasonal female sex contribution of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

Time period	Run Size (N)	Sample size (n)	Percent female
Jun 22-30	57	37	49 (8.3)
Jul 1-7	3,032	147	52 (4.1)
Jul 8-14	8,087	138	59 (4.2)
Jul 15-21	10,249	129	67 (4.2)
Jul 22-28	3,031	145	62 (4.0)
Jul 29-Aug 2	793	136	66 (4.1)
Total	25,249	732	60 (2.3)

Table 24. Percent sex contribution by age of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2002. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.

					Brood year and age			
					1999	1998	1997	1996
Sex	Run size (N)	Sample size (n)	Unknown	Seasonal sex percentage	0.2	0.3	0.4	0.5
Female	15,601	442	73	60	0 (0.1)	18 (2.1)	79 (2.3)	3 (1.1)
Male	9,648	290	69	40	0 (0.0)	12 (2.9)	83 (3.1)	5 (1.3)

Table 25. Age distribution of Chinook salmon sampled at Gisasa River, Kateel River, and Henshaw Creek weirs, Alaska, 2002.

				Percent of age class			
Study sites	Run size (N)	Sample size (n)	Unknown	1.2	1.3	1.4	1.5
Gisasa River	2,025	526	44	32%	42%	23%	3%
Kateel River	73	66	3	50%	36%	14%	0%
Henshaw Creek	649	347	39	30%	36%	31%	2%

Table 26. Age distribution of summer chum salmon sampled at Gisasa River, Kateel River, and Henshaw Creek weirs, Alaska, 2002.

				Percent of age class			
Study sites	Run size (N)	Sample size (n)	Unknown	0.2	0.3	0.4	0.5
Gisasa River	33,481	777	106	1%	60%	37%	3%
Kateel River	2,853	524	66	0%	58%	38%	4%
Henshaw Creek	25,249	732	142	<1%	16%	80%	4%

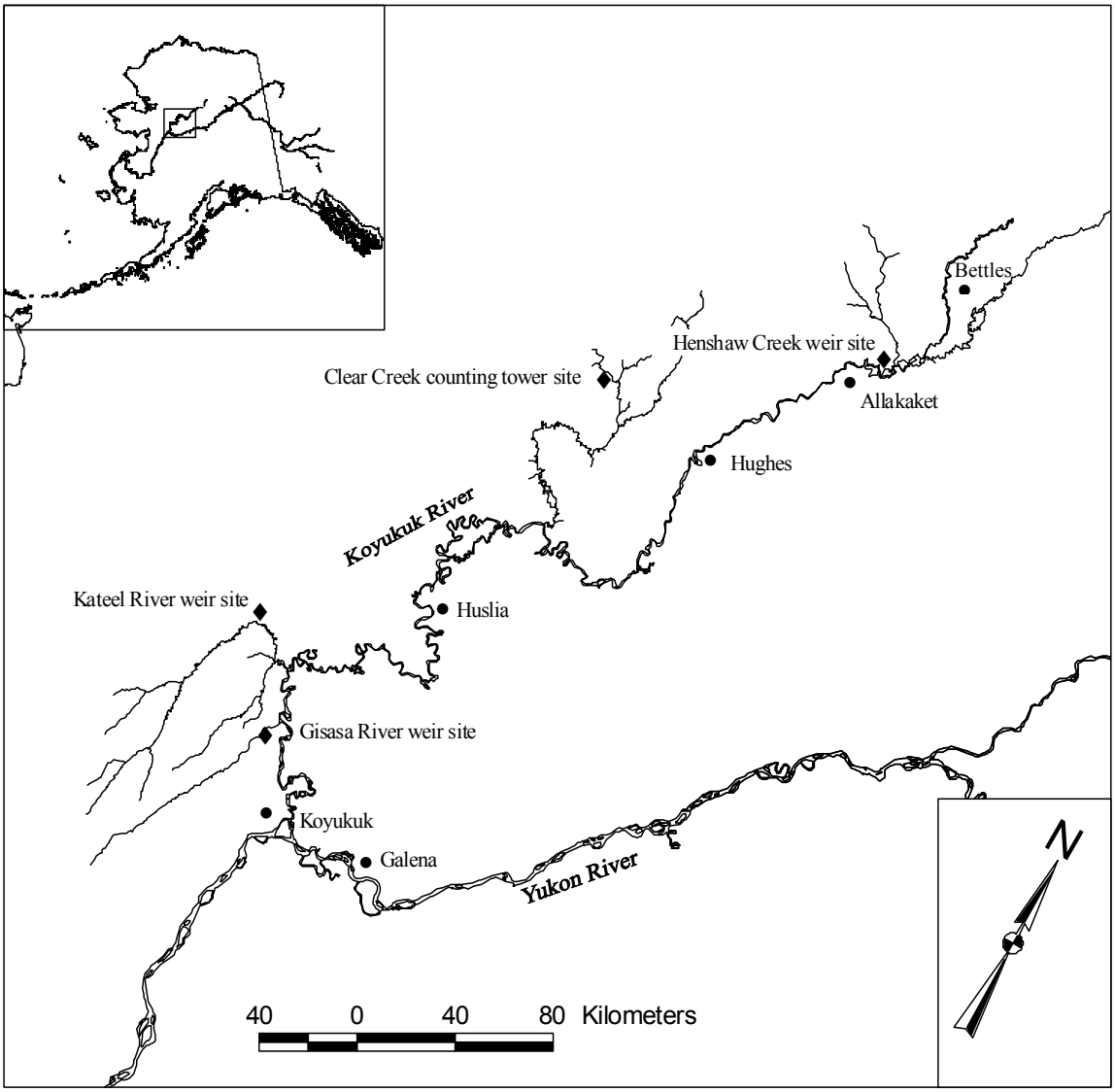

Figure 1. The Koyukuk River and tributary escapement study sites (♦), Alaska, 2002.

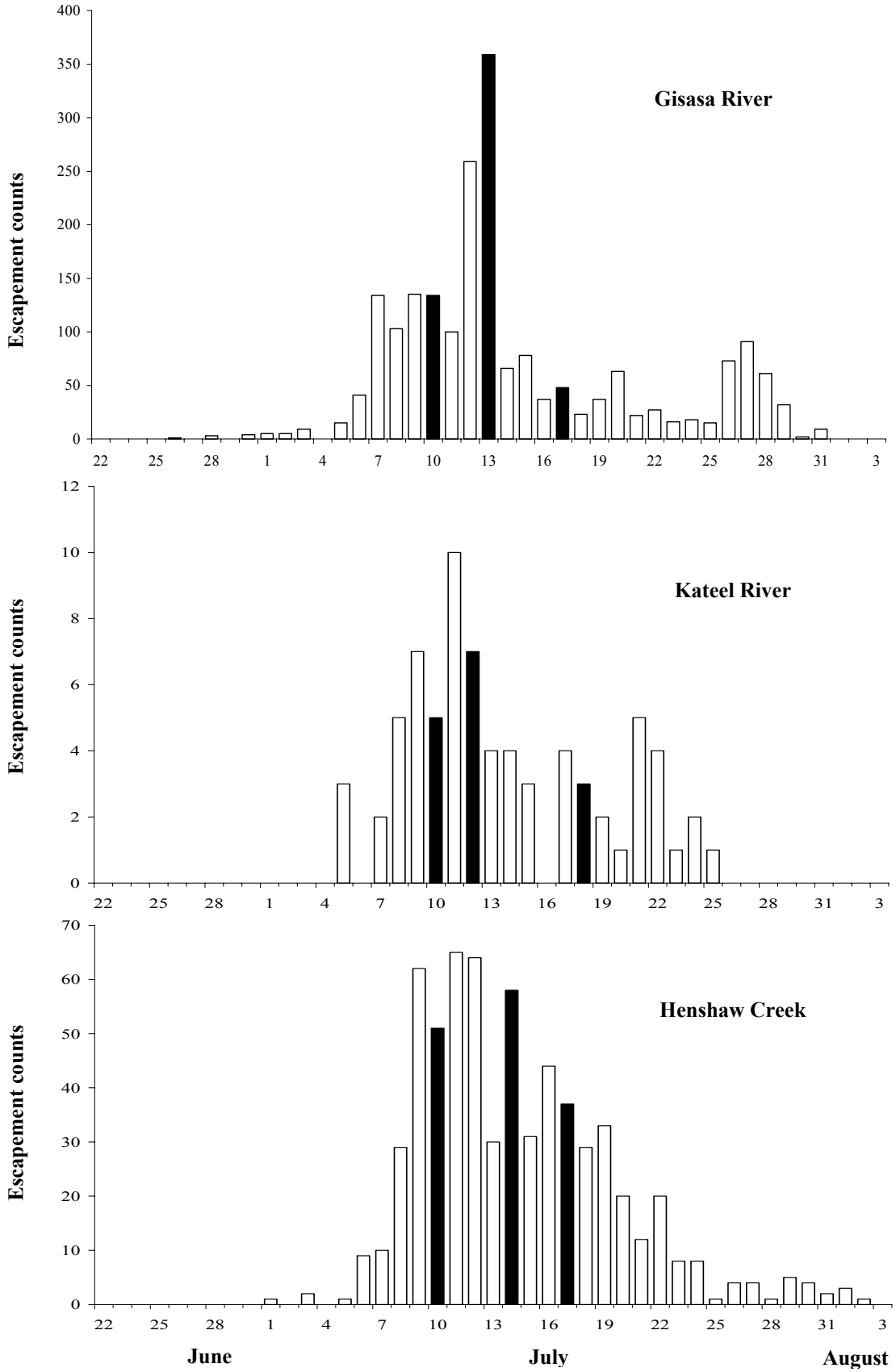

Figure 2. Daily escapement counts of Chinook salmon recorded at Gisasa River, Kateel River, and Henshaw Creek weirs, Alaska, 2002. Shaded areas represent first, middle, and third quartile of run.

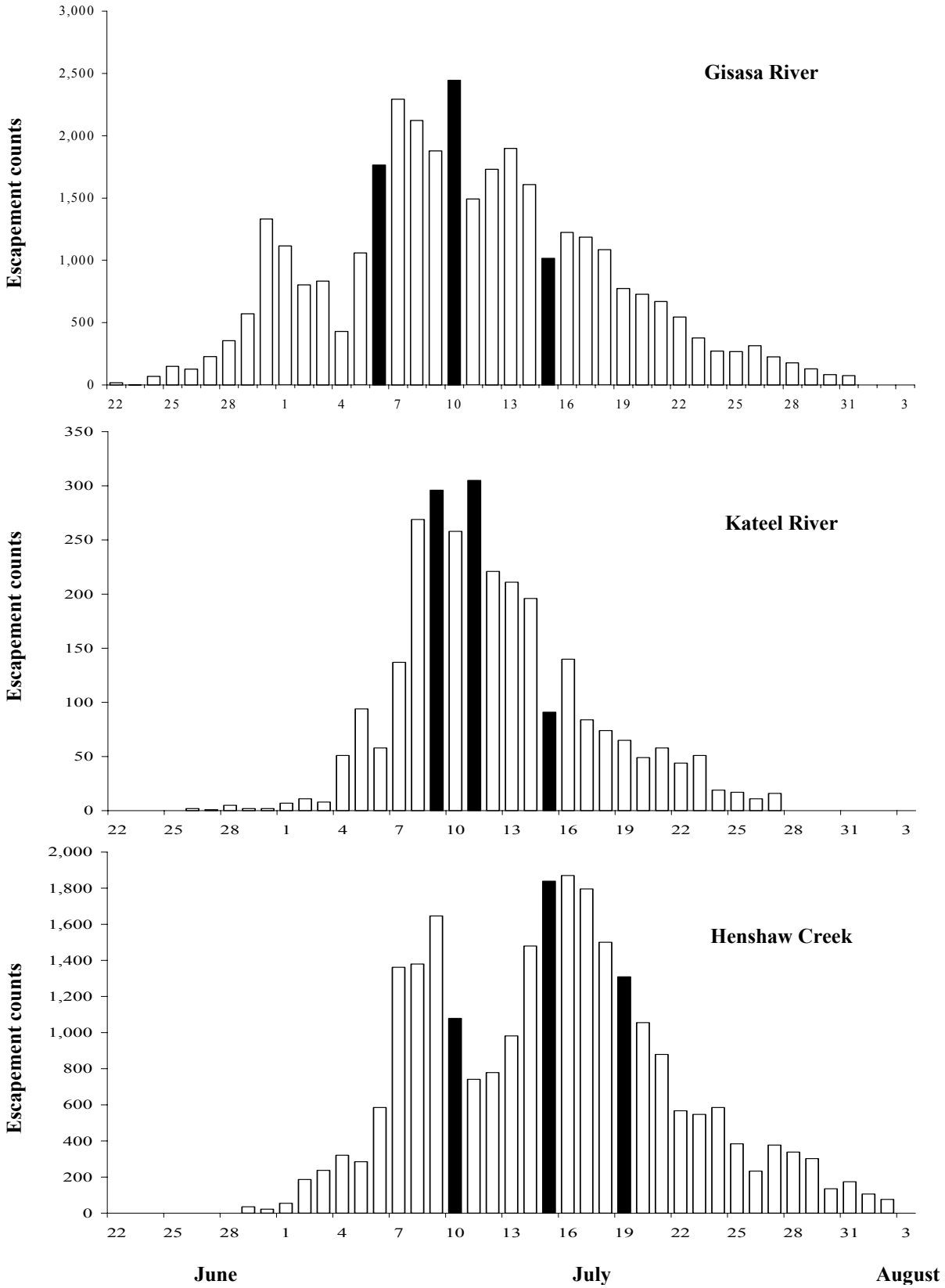

Figure 3. Daily escapement counts of summer chum salmon recorded at Gisasa River, Kateel River, and Henshaw Creek weirs, Alaska, 2002. Shaded areas represent first, middle, and third quartile of run.

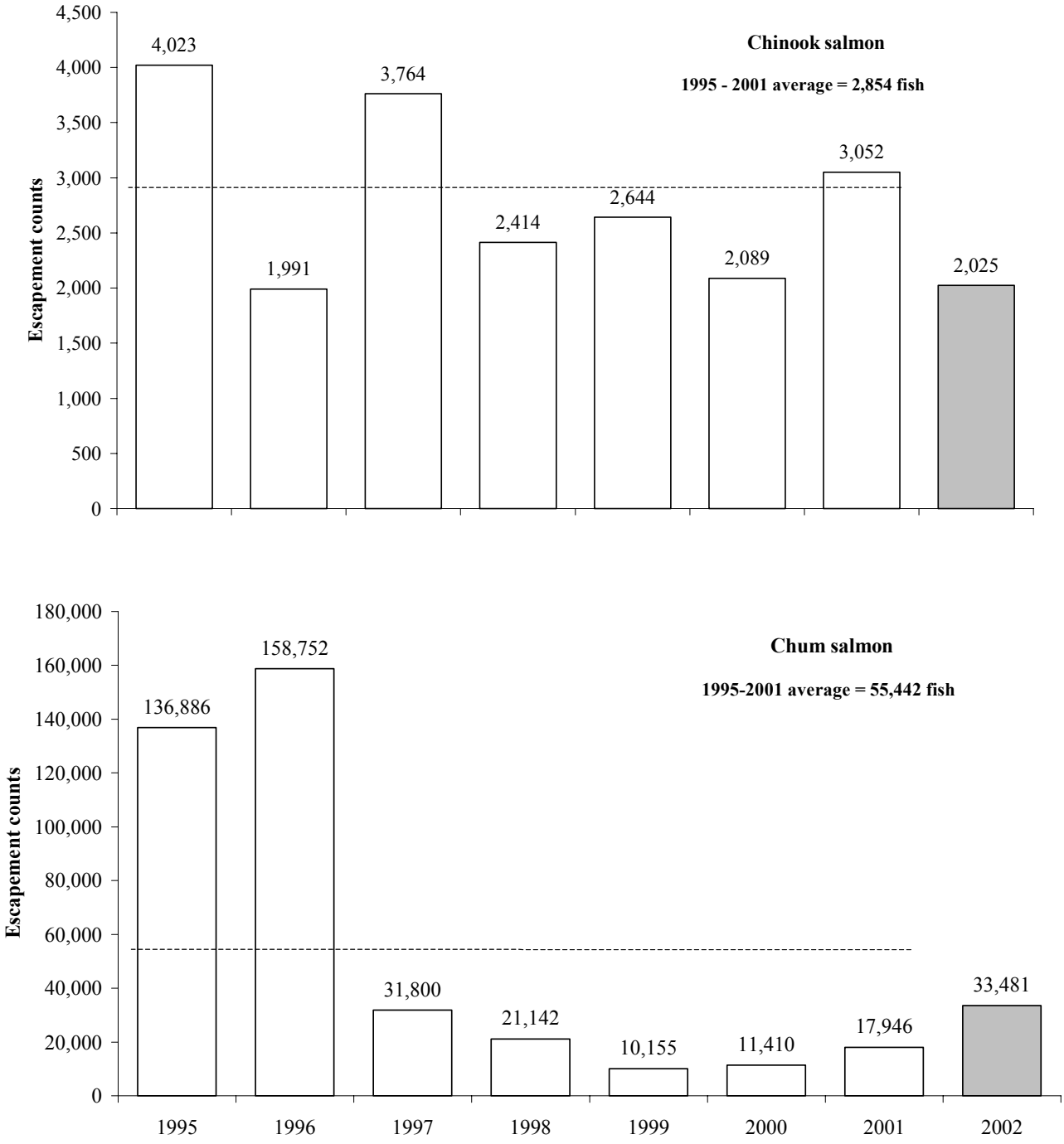

Figure 4. Chinook and summer chum salmon escapement counts recorded at Gisasa River weir, Alaska, 1995-2002. Dashed line represents average annual count from 1995 – 2001.

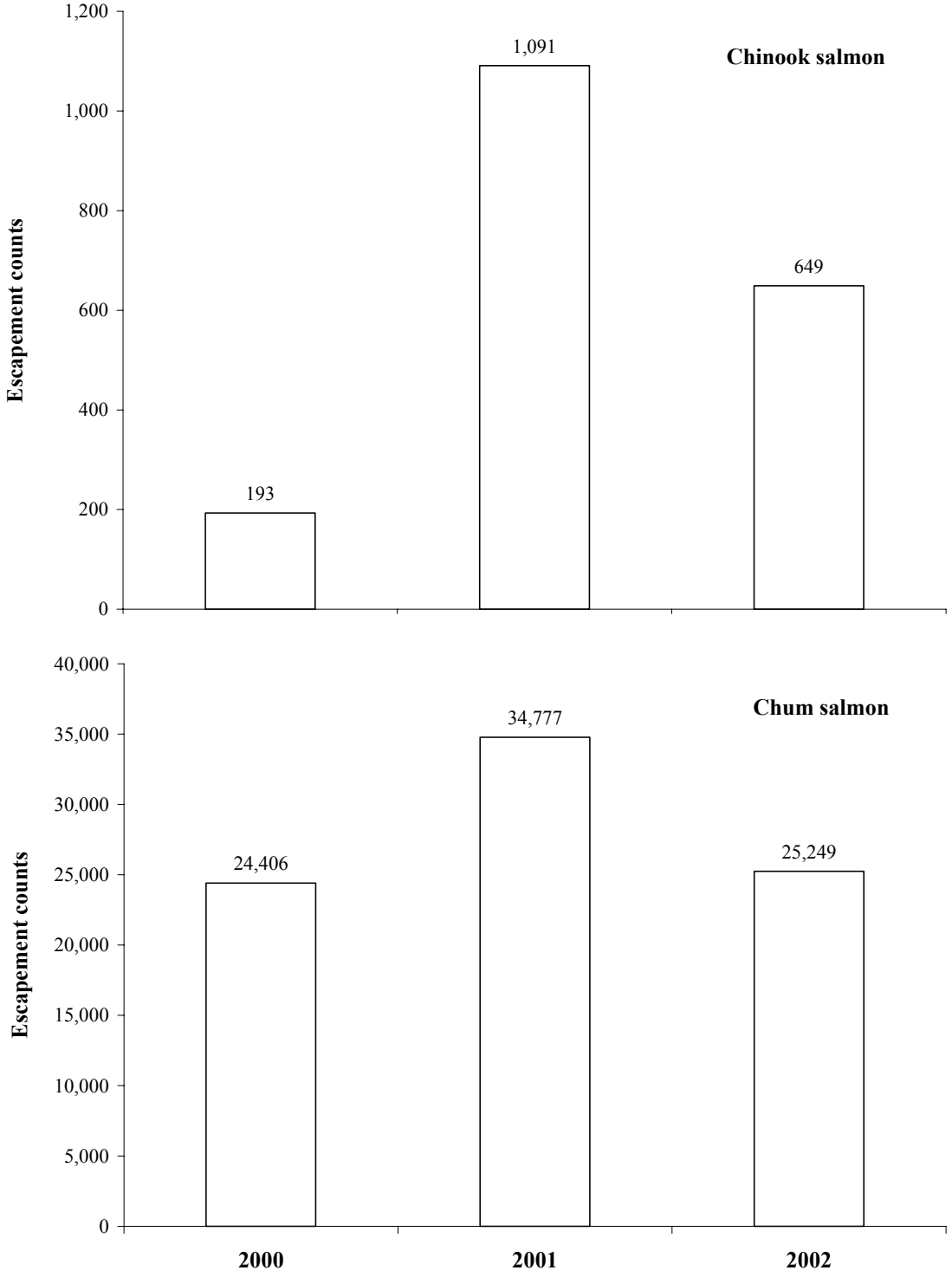

Figure 5. Chinook and summer chum salmon escapement counts recorded at Henshaw Creek weir, Alaska, 2000-2002.

Appendix 1. Historical Chinook and summer chum salmon escapements for Gisasa River, Alaska, 1960-2001. * indicates partial weir count in 1994.

	Aerial index estimates			Weir	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon
1960	300	400	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		
1984					
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				1,991	158,752
1997	144	686	Good	3,764	31,800
1998	889		Poor	2,414	21,142
1999				2,644	10,155
2000				2,089	11,410
2001				3,052	17,946

Appendix 2. Historical Chinook and summer chum salmon escapements for Kateel River, Alaska, 1974-1992.

	Aerial index estimates		
Year	Chinook salmon	Chum salmon	Rating
1974	14	1,661	Not rated
1975	60	8,552	Not rated
1976	8	238	Fair
1990	185	338	Good-fair
1992	65	800	Fair

Appendix 3. Historical Chinook and summer chum salmon escapements for Henshaw Creek, Alaska, 1969-2001. * indicates partial tower count in 1999.

	Aerial index estimates			Counting tower		Weir	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon	Chinook salmon	Chum salmon
1969	6	300	Not rated				
1975	118	1,219	Not rated				
1976	94	624	Fair				
1982	48	12	Fair				
1983	551	3,289	Good				
1984	253	532	Poor				
1985	393	3,724	Good				
1986	561	2,475	Fair				
1987	20	35	Not rated				
1988	180	1,106	Good-poor				
1990	369	1,237	Good-fair				
1991	455	2,148	Good				
1994	526	2,165	Fair				
1996	138	24,780	Fair				
1998	97	151	Fair				
1999				12*	1,510*		
2000						193	24,406
2001						1,091	34,777