U.S. Fish & Wildlife Service

Abundance and Run Timing of Adult Pacific Salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 2007

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Kenai Fish and Wildlife Field Office
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Miranda P. Plumb and Ken C. Harper

Abstract

The Kenai Fish and Wildlife Field Office operated a weir on the Tuluksak River, a tributary to the lower Kuskokwim River in the Yukon Delta National Wildlife Refuge, between June 20 and September 10, 2007. The resistance board weir was used to collect abundance, run timing, and biological data from returning salmon. These data supported in-season management of the commercial and subsistence fisheries in the Kuskokwim area. In 2007, 16,762 chum *Oncorhynchus keta*, 371 Chinook *O. tshawytscha*, 2,768 coho salmon *O. kisutch*, 345 sockeye *O. nerka*, and 61 pink *O. gorbuscha* passed the Tuluksak River weir. Peak weekly passage occurred from July 15 to 28 for Chinook, chum, and sockeye salmon, from July 29 to August 4 for pink salmon, and from August 26 to September 1 for coho salmon. Fish passage was calculated for 4 days when either partial or no escapement numbers were collected due to high water events. Escapement estimates were generated using average daily proportions of fish passing the weir on those days between 1991-1993 and 2002-2006. Based on corrections made to actual counts we estimated that 17,286 chum, 374 Chinook, 2,807 coho, 352 sockeye, and 64 pink salmon escaped in 2007. Age 1.4 Chinook, 0.3 chum, 2.1 coho, and 1.3 sockeye salmon were the dominant age classes. Thirty-one percent of chum salmon, 48% of Chinook salmon, 36% of coho salmon, and 40% of sockeye salmon were females.

Introduction

The Tuluksak River, located approximately 222 river kilometers (rkm) upstream from the mouth of the Kuskokwim River, Alaska, (Whitmore et al. 2005) flows through the Yukon Delta National Wildlife Refuge (Refuge) and supports spawning populations of Chinook, chum, pink, coho, and a small population of sockeye salmon. These salmon contribute to large subsistence and commercial fisheries in the lower Kuskokwim River drainage. In addition to human consumption, salmon provide food for brown bears and other carnivores, raptors and scavengers. These salmon also sustain resident fish species and salmon fry that rely heavily on the nutrient base provided by salmon carcasses (U.S. Fish and Wildlife Service 1992).

Under guidelines established in the Sustainable Salmon Fisheries Policy 5AAC.39.222, in September 2000 the Alaska Board of Fisheries designated Kuskokwim River chum and Chinook salmon as yield concerns. This designation was based upon the continued inability, despite specific management measures, to maintain expected yields, or have stable surplus above the stock's escapement needs. Beginning in January 2001, the salmon fishery in the Kuskokwim River drainage was managed under the Kuskokwim River Salmon Rebuilding Management Plan (Rebuilding Plan) (5AAC 07.365; Ward et al. 2003; Bergstrom and Whitmore 2004). In 2007, the designation was discontinued based on chum and Chinook salmon runs above or at the historical average since 2002 (Linderman and Rearden 2007).

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The Alaska Department of Fish and Game (Department), the U.S. Fish and Wildlife Service (Service), and the Kuskokwim River Salmon Management Working Group (Working Group) work together to achieve the goals of both Kuskokwim River Salmon Management Plan (5 AAC 07.365) and the Federal Subsistence Fishery Management program. In addition to the goals set by the Department, the Service, and the Working Group, the Alaska National Interest Lands Conservation Act (ANILCA) mandates that salmon populations and their habitats be conserved in their natural diversity within the Refuge.

The current array of escapement monitoring projects has a broad geographic distribution that samples a diverse collection of widely separated salmon spawning aggregates, and this provides vital insight into sustainable salmon management in the Kuskokwim Area. Recent tagging studies conducted on Chinook, sockeye, chum and coho salmon have all demonstrated differential stock-specific run timings with the general pattern of salmon stocks from upper river tributaries entering the Kuskokwim River earliest, while stocks from lower river tributaries enter progressively later (Kerkvliet and Hamazaki 2003; Kerkvliet et al. 2003, 2004; Stuby 2004, 2005, 2006). The temporal distribution of these stock-specific run timings overlap; the difference between the mid-point of one stock and another of the same species can be several weeks. Concurrent with this phenomenon is the occurrence of extensive subsistence fisheries that tend to harvest more heavily from early arriving salmon, and commercial fisheries that have historically focused on early, middle or late segments of the overall salmon run (D. Molyneaux, Alaska Department of Fish and Game, personal communication). This mixture of different stock-specific run timings and uneven distribution of harvest, produce the possibility of significant differential exploitation rates between stocks or stock aggregates. This situation mandates that managers develop and maintain a rigorous monitoring program capable of assessing the adequacy of escapements throughout the geographic range of each species; further, managers must monitor those escapements to assess for trends that may be detrimental to the overall vitality of salmon runs. To manage for sustained yields and conservation of individual salmon stocks, managers need escapement data and migratory timing of individual stocks accompanied by sex and age composition throughout the migratory period.

In previous years, salmon escapements were monitored using aerial surveys as indices of relative abundance and a resistance board weir (Tobin 1994) in the Tuluksak River. Aerial surveys started in 1965 and occurred sporadically until 2003 (Harper 1997; Ward et al. 2003; Whitmore et al. 2005). These surveys were infrequently used for in-season management of the Kuskokwim River fisheries because the surveys often occurred after the commercial and subsistence fishing seasons.

Monitoring total salmon escapement has been accomplished since 1991 using a resistance board weir. The resistance board weir has been routinely installed from 1991 to 1994, and from 2001 to 2007. A weir was not operated on the Tuluksak River between 1995 and 2000.

In 2004, the Tuluksak River escapement monitoring project transitioned from a cooperative agreement to a contract between the Service and the Village of Tuluksak. This contract has continued to meet the goals of the Service, Department, Working Group and the mandates of ANILCA.

The Tuluksak River salmon escapement project objectives were to: (1) count the daily passage of chum, Chinook, coho, sockeye, and pink salmon and resident fish species through a weir on the Tuluksak River; (2) describe run-timing using daily passage counts of chum, Chinook, coho,

sockeye, and pink salmon passing through the weir; (3) estimate weekly age and sex composition of chum, Chinook, and coho salmon passing through the weir; (4) determine the length of chum, Chinook, and coho salmon by age and sex; (5) enumerate chum, Chinook, coho, sockeye, and pink salmon carcasses washing onto the weir each day. These data will support the in-season management of the Kuskokwim River subsistence and commercial fisheries. The data will also aid decisions in setting biological escapement goals to maintain the sustainability of salmon resources.

Study Area

The Tuluksak River is one of several tributaries flowing into the lower Kuskokwim River and is located approximately 116 rkm northeast of Bethel, AK (Whitmore et al. 2005). The Tuluksak River is approximately 137 rkm in length and its watershed encompasses approximately 2,098 km^2 (Harper 1997) (Figure 1). It originates in the Kilbuck Mountains and flows to the northwest. The Fog River drains into the lower portion of the Tuluksak River and is the only major tributary. The Tuluksak River is a medium gradient river for the majority of its length and is characterized by dense overhanging vegetation and cut banks. The lower portion of the river is characterized by low-gradient, silty substrate and turbid waters.

The river section at the weir site, approximately 49 rkm from the mouth, is 42 m wide, shallowest in mid-river and deepest near the banks. The substrate contains primarily sand mixed with fine gravel. Water clarity is moderately clear but can become turbid during rainy periods and when boat traffic is present.

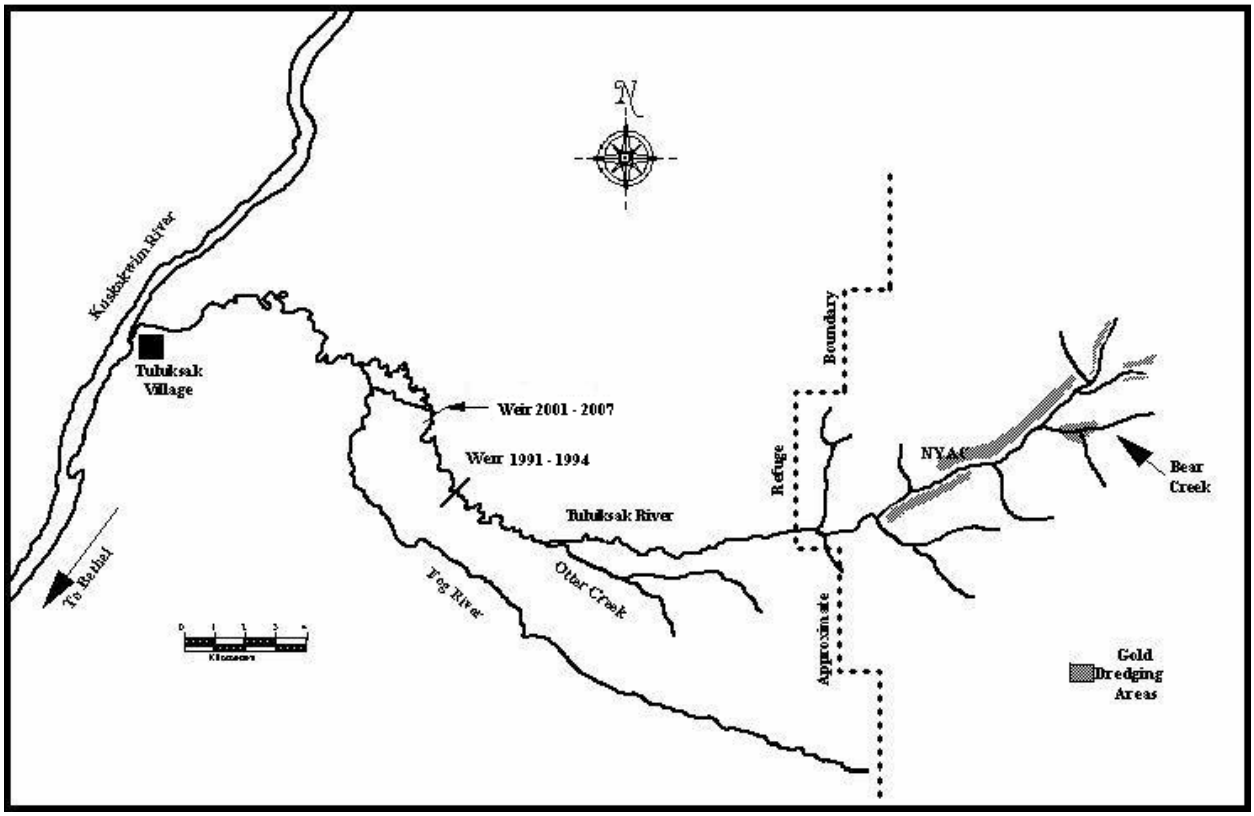

FIGURE 1.—Tuluksak River weir location, Yukon Delta National Wildlife Refuge, 1991-1994 and 2001-2007.

Methods

Weir Operations

A resistance board weir (Tobin 1994) was installed in 2007 in the Tuluksak River at rkm 49 (61°02.641') (W160°35.049'). This location is approximately 16 rkm downstream from the weir site used between 1991 and 1994 (Harper 1995a, 1995b, 1995c, 1997). The weir was relocated to a position down stream of known salmon spawning areas. The lower site also provides easier boat access to the weir and campsite during low water conditions.

This weir was modified slightly from the previous weir design used between 1991 and 1994 (Tobin 1994). A range of modifications took place in 2001 to increase efficiency of installation, operations, and takeout (Gates and Harper 2002).

Two passage panels were installed, one was approximately 7.6 m from the left bank and the other 7.6 m from the right bank. Live traps were attached to both passage chutes to facilitate efficient fish sampling during various river stage heights. Counts started at approximately 0800 hours every day and continued until visibility was too poor to identify salmon by species. All passing salmon and resident fish were identified to species and recorded.

A stream gauge was installed near the shore on the river right bank approximately 10 m downstream of the weir. The stream gauge (cm) was read twice daily and noted in the field log. To compensate for the placement of the stream gauge and to have it more accurately reflect the water depth across the river, an average water depth and stream gauge reading were taken simultaneously post installation. Water temperatures were recorded twice daily using a standard thermometer (ºC). Temperature data were then averaged for each day.

Biological Data

Statistical weeks started on a Sunday and continued through the following Saturday (Harper 1997). Target sample size consisted of 200 chum salmon, 210 Chinook salmon, and 170 coho salmon each week. Sampling for sockeye salmon was opportunistic with a target sample of 75 fish for the season. Biological sampling occurred between Sunday and Thursday of each statistical week in order to obtain a snapshot sample (Geiger et al. 1990). Once the weekly sample quota was met for a particular species, sampling would stop for that species and continue for others but typically would not extend past Thursday. Low daily numbers of Chinook salmon relative to other species required active sampling throughout the season to meet the weekly sample quota (Linderman et al. 2002). Post season analysis included the combination of weekly strata to ensure adequate samples sizes were obtained.

For some salmon species, the sample size goal was expected to be a substantial fraction of the passage in some weeks. Therefore, during weeks of low passage if 20% of the weekly escapement was sampled, sampling was suspended for that species. This was sufficient to describe the age composition and reduce fish numbers handled at the weir.

Age, sex, and length data were collected from each sampled salmon. Sampled fish were caught using the live trap attached to the passage chute. A fyke gate, installed on the entrance of the trap, allowed fish to enter and at the same time minimized the number of fish exiting the trap downstream. Sampling occurred when approximately 40 fish were in the trap. To avoid potential bias caused by the selection or capture of individual fish, all target species within the trap were included in the sample even if the sample size goal for a species was exceeded. Four

scales were extracted from Chinook and coho salmon, three scales from sockeye salmon, and one was extracted from chum salmon for age determination. All scales were taken from the preferred area using methods described by Koo (1962) and Mosher (1968). Sex was determined by observing external characteristics, and length was measured to the nearest 5 mm from the mid-eye to the fork of the caudal fin. All data was recorded and then transferred to mark-sense forms at the end of each sample day. Mark-sense forms were processed by the Department when their personnel completed aging of the scales.

Salmon carcasses that washed onto the weir were counted by species and passed downstream. Each crew member counted carcasses when they began a counting shift, resulting in the weir being cleaned at least every four hours.

Salmon ages were reported according to the European Method (Koo 1962) where numerals preceding the decimal denote freshwater annuli and numerals following the decimal denote marine annuli. Total years of life at maturity is determined by adding one year to the sum of the two digits on either side of the decimal (i.e. age 1.4 and 2.3 (1.4=1+4+1=6 and 2.3=2+3+1=6) are both six-year-old fish from the same parent year). The parent year is determined by subtracting fish age from the current year.

Characteristics of fish passing through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum m, the proportion of species i passing the weir that are of sex j and age k (pijkm) was estimated as

$$\hat{p}_{ijkm} = \frac{n_{ijkm}}{n_{i++m}},$$

where n_{ijkm} denotes the number of fish of species i, sex j, and age k sampled during stratum m and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{i++m} denotes the total number of fish of species i sampled in stratum m. The variance of $\hat{p}_{ijkm}$ was estimated as

$$\hat{v}\left(\hat{p}_{ijkm}\right) = \left(1 - \frac{n_{i++m}}{N_{i++m}}\right) \frac{\hat{p}_{ijkm}\left(1 - \hat{p}_{ijkm}\right)}{n_{i++m} - 1},$$

where N_{i++m} denotes the total number of species i fish passing the weir in stratum m. The estimated number of fish of species i, sex j, age k passing the weir in stratum m (N_{ijkm}) is

$$\hat{N}_{ijkm} = N_{i++m}\,\hat{p}_{ijkm},$$

with estimated variance

$$\hat{v}\left(\hat{N}_{ijkm}\right) = N_{i++m}^{2}\,\hat{v}\left(\hat{p}_{ijkm}\right).$$

Estimates of proportions for the entire period of weir operation were computed as weighted sums of the stratum estimates, i.e.,

$$\hat{p}_{ijk} = \sum_m \left(\frac{N_{i++m}}{N_{i+++}} \right) \hat{p}_{ijkm}$$

with estimated variance

$$\hat{v}\left(\hat{p}_{ijk} \right) = \sum_m \left(\frac{N_{i++m}}{N_{i+++}} \right)^2 \hat{v}\left(\hat{p}_{ijkm} \right).$$

The total number of fish in a species, sex, and age category passing the weir during the entire period of operation was estimated as

$$\hat{N}_{ijk} = \sum_m \hat{N}_{ijkm} ,$$

with estimated variance

$$\hat{v}\left(\hat{N}_{ijk} \right) = \sum_m \hat{v}\left(\hat{N}_{ijkm} \right).$$

If the length of the r^{th} fish of species i, sex j, and age k sampled in stratum m is denoted x_{ijkmr}, the mean length of all such fish (μ_{ijkm}) was estimated as

$$\hat{\mu}_{ijkm} = \left(\frac{1}{n_{ijkm}} \right) \sum_r x_{ijkmr} ,$$

with corresponding variance estimator

$$\hat{v}\left(\hat{\mu}_{ijkm} \right) = \left(1 - \frac{n_{ijkm}}{\hat{N}_{ijkm}} \right) \frac{\sum_r \left(x_{ijkmr} - \hat{\mu}_{ijkm} \right)^2}{n_{ijkm}\left(n_{ijkm} - 1 \right)}$$

The mean length of all fish of species i, sex j, and age k ($\mu_{ijk)}$ was estimated as a weighted sum of the stratum means, i.e.,

$$\hat{\mu}_{ijk} = \sum_m \left(\frac{\hat{N}_{ijkm}}{\hat{N}_{ijk}} \right) \hat{\mu}_{ijkm}$$

An approximate estimator of the variance of $\hat{\mu}_{ijk}$ was obtained using the delta method (Seber 1982),

$$\hat{v}\left(\hat{\mu}_{ijk}\right) = \sum_{m}\left\{\hat{v}\left(\hat{N}_{ijkm}\right)\left[\frac{\hat{\mu}_{ijkm}}{\sum_{x}\hat{N}_{ijkx}} - \sum_{y}\frac{\hat{N}_{ijky}\,\hat{\mu}_{ijky}}{\left(\sum_{x}\hat{N}_{ijkx}\right)^{2}}\right]^{2} + \left(\frac{\hat{N}_{ijkm}}{\sum_{x}\hat{N}_{ijkx}}\right)^{2}\hat{v}\left(\hat{\mu}_{ijkm}\right)\right\}$$

A two-sample t-test $\alpha = 0.05$ (Systat 11.0) was used to test the hypothesis that male and female Chinook salmon of age k have equal mean lengths. Data were pooled across all strata and treated as one sample to compare lengths.

Days with partial counts were considered incomplete. Estimates were calculated for these dates and were based on the average daily proportion of passage from data collected between 1991-1993 and 2002-2006. An average of the daily proportions for previous years data was calculated since daily escapement can vary between years. The sum of the averaged daily proportions, calculated for days with zero counts, is the estimated total escapement missed. The total escapement is the sum of the observed counts during 2007 divided by one minus the proportion missed in 2007. Estimates were calculated for portions of 1994 and 2001 (Gates and Harper 2002; Harper 1997). These estimated counts were not used when calculating the 2007 estimates.

Results

Weir Operations

The weir was installed on June 20, 2007, and operated through September 10, 2007. During installation, the rail was adjusted to compensate for substrate change that occurred over winter and spring break-up. The weir was installed in the same location as 2006. Minor repairs were made to damaged weir components during the 2007 field season. The weir was removed on September 11.

Average water depth during 2007 was 88 cm. The minimum water depth of 40 cm occurred on June 22 and the river rose to a maximum depth of 205 cm on August 8 (Appendix 1). Water temperatures averaged 10°C, and ranged from 8.8°C on September 1 to 13°C on June 21 (Appendix 1).

Biological Data

Chum Salmon—A total of 16,762 chum salmon were counted through the weir between June 25 to September 10. Forty-three chum salmon that passed the weir (<1%) were observed with gill net marks. Peak weekly passage (N=4,949), representing 30% of the escapement, occurred between July 15 and July 21 (Figure 2). The observed median cumulative passage date occurred on July 21 (Appendix 2). An estimated 524 chum salmon passed the weir during the high water event from August 6 to 9 for a total estimated passage of 17,286 (Appendix 2).

Four ages were identified from 1,023 of the 1,130 chum salmon sampled at the weir. Female chum salmon comprised less than 50% of the weekly passage through the majority of the run and 31% of the escapement (Figure 3, Appendix 3). Age 0.3 chum salmon were the most abundant, accounting for 73% of the aged sample (Appendix 3). Lengths of age 0.3 chum salmon ranged from 425 to 650 mm (Appendix 4).

Chum salmon carcasses were first recorded on July 1. Median cumulative passage dates for escaping chum salmon and chum salmon carcasses washing onto the weir were separated by 18 days (Figure 4). A total of 3,040 chum salmon carcasses passed downstream over the weir from July 1 to September 9. It is unknown how many carcasses may have washed over the weir during high water.

Chinook Salmon—A total of 371 Chinook salmon were counted through the weir between June 30 and August 15. Twenty Chinook salmon that passed the weir, (5 %) were observed with gill net marks. Peak weekly passage occurred between July 22 and July 28 (N=108) (Figure 2). The median cumulative passage date occurred on July 19 (Appendix 2). An estimated three Chinook salmon passed the weir during the high water event from August 6 to 9 for a total estimated passage of 374 (Appendix 2).

Five age groups were identified from 197 of the 233 Chinook salmon sampled between June 30 and August 5 (Appendix 5). Female Chinook salmon comprised less than 30% of the weekly passage through the first half of the run, and composed an estimated 48% of the total escapement (Figure 3, Appendix 5). Age 1.3 and 1.4 dominated the Chinook salmon escapement with 27%, and 56% (Appendix 5).

Lengths at age for 1.3 and 1.4 Chinook salmon ranged from 570 to 1,100 mm (Appendix 6). Mean lengths of age 1.3 females was greater than that of same aged males (Appendix 6). Mean lengths of age 1.4 males and females were not significantly different (Appendix 6). Insufficient samples were available for comparison of same age males and females in age groups 1.2 and 1.5.

Chinook salmon carcasses (N=113) were observed on the weir starting July 5. The median cumulative passage dates for daily escapement and carcasses were separated by 26 days (Figure 4). It is unknown how many carcasses may have washed over the weir during high water.

Coho Salmon—Coho salmon (N=2,768) were counted through the weir between July 17 and September 10. Gillnet marks (N=28) were observed on 1% of the coho salmon passing the weir. Peak weekly passage (N=815) was estimated to occur between August 26 and September 1 (Figure 2). The median cumulative passage date occurred on August 23 (Appendix 2). An estimated 39 coho salmon passed the weir during the August 6 to 9 high water event and after weir operations for a total estimated passage of 2,807 (Appendix 2).

Three ages were assigned to 564 of the 668 coho salmon sampled at the weir. Females composed 36% of the coho salmon escapement (Figure 3; Appendix 7). The majority (86%) of the coho salmon were age 2.1 (Appendix 7). The remaining sample was comprised of age 1.1 (10%) and 3.1 (4%) fish. Lengths of age 2.1 coho salmon ranged from 400 to 650 mm (Appendix 8).

The first coho salmon carcass was recorded on August 15. By September 10 2007, the last day of counting, only 16 coho salmon carcasses were passed.

Sockeye Salmon—Sockeye salmon (N=345) were counted through the weir between July 7 and August 29. Three sockeye salmon that passed the weir (<1%) were observed with gill net marks. Peak weekly passage occurred between July 22 and 28 (N=106) (Figure 2), with a median cumulative passage date of July 22 (Appendix 2). An estimated seven sockeye salmon passed the weir during the August 6 to 9 high water event for a total estimated passage of 352 (Appendix 2).

Four age classes were identified from 65 sampled sockeye salmon. Females composed 40% of the sockeye salmon escapement (Appendix 9). The majority (75%) of the sockeye salmon were age 1.3, and age 1.2 (22%) (Appendix 9). Lengths of age 1.3 sockeye salmon ranged from 460 to 615 mm, and lengths of age 1.2 ranged from 500 to 595mm (Appendix 10).

One hundred fifty-five sockeye salmon carcasses were counted on the upstream side of the weir during 2007. The first carcass washed onto the weir on July 18, eleven days after the first sockeye salmon passed through the weir. It is unknown how many carcasses may have washed over the weir during high water.

Pink Salmon—Pink salmon (N=61) passed the weir between July 8 and September 10. No gill net marks were observed on pink salmon that passed the weir. Peak weekly passage was observed between July 29 and August 4 (N=17) (Figure 2). The median cumulative passage date was July 30 (Appendix 2). An estimated three pink salmon passed the weir during the high water event from August 6 to 9 for a total estimated passage of 64 (Appendix 2).

The first pink salmon carcass washed onto the weir on July 28, twenty days after the first pink salmon was counted through the weir. The median cumulative passage dates for daily escapement and carcasses were separated by 26 days (Figure 4). Forty-nine pink salmon carcasses were counted on the weir during operations, which accounted for 80% of the pink salmon counted through the weir. It is unknown how many carcasses may have washed over the weir during high water.

Resident Species—Resident species counted through the weir consisted of one Dolly Varden, nine whitefish, three Northern pike, and four Arctic grayling. Although smaller sized resident species were able to pass freely through the pickets, passage through the passage chutes was recorded throughout the entire season. One Dolly Varden, ten whitefish, three Northern pike and four Arctic grayling carcasses were recorded on the weir.

Discussion

Weir Operations

The weir was operated from June 20 through September 10, 2007. Installation was facilitated by low water depths during June. The substrate rail and cable were left in place to expedite installation in 2008.

Biological Data

Chum Salmon—The estimated chum salmon escapement in 2007 (*N*=17,286) was within the historic range of 7,675 to 35,696 fish (Figure 5), and above the historical average (*N*=14,695) (Gates et al 2002; Harper 1995a, b, c, Harper 1997; Zabkar et al. 2006, Plumb et al. 2007). The 2007 escapement was 48% of the record 2005 chum salmon escapement (*N*=35,696). The median passage date for chum salmon occurred on July 21 (Figure 6), only two days from the historical average of July 20 (Gates and Harper 2003; Zabkar and Harper 2004).

Other escapement projects located on Kuskokwim River tributaries indicate the 2007 chum salmon escapement was above the recorded average. Chum salmon escapement at the Kwethluk, George, and Tatlawiksuk River monitoring projects were the highest on record (Linderman and Bue 2007).

Females only comprised 31% of the total chum salmon escapement, which is lower than the 2001-2006 escapements which ranged from 33-48% (Gates and Harper 2002, 2003; Zabkar and Harper 2004; Zabkar et al. 2006, Plumb et al. 2007). Males were the dominate sex during the major portion of the run (Figure 3, Appendix 3).

Age 0.3 chum salmon comprised 73% of the return in 2007, an increase from 46% in 2006 (Plumb et al. 2007). Age 0.4 chum salmon decreased from 51% in 2006 to 22% in 2007. The high percentage of age 0.3 (73%) and 0.4 (22%) chum salmon were from the 2003 and 2002 brood years (Appendix 3).

Gill net marks (N=43) were observed on <1% of the chum salmon passing the weir, similar to 2003-2006, where <1% gill net marked chum salmon were observed (Harper 1995a, 1995b, 1995c, 1997; Gates and Harper 2002, 2003; Zabkar and Harper 2004; Zabkar et al. 2006, Plumb et al. 2007). Gill net marks were more frequently observed during years when a commercial harvest of chum salmon occurred in late June and early July, as confirmed in 1991 and 1992 (5% and 4%, respectively) when commercial fishing occurred. Commercial fishing directed at coho salmon occurred after August 1 in 2007, and some Chinook, chum, and sockeye salmon were also harvested. The commercial fishing periods did not appear to influence the amount of gill net marks observed at the weir (<1%).

Chinook Salmon—The estimated Chinook salmon escapement during 2007 (N=374) was the lowest on record, and well below the historical average (N=1,611) (Figure 5). Run timing in 2007 was one of the latest on record; the median passage date occurred seven days after the average (Figure 6; Appendix 2). From 1991-1994 and 2001 - 2005 the Chinook salmon median passage dates were between July 5 and July 14 (Gates and Harper 2003; Zabkar and Harper 2004; Zabkar et. al 2006), but the median passage date for both 2006 and 2007 was July 19.

In past years, a subsistence-fishing schedule maintained 'windows' of fishing opportunity in the Kuskokwim River drainage, but this year the Alaska Board of Fisheries discontinued the stock of concern designations for Kuskokwim River chum and Chinook salmon (Linderman and Bergstrom 2006). Subsistence fishing was allowed seven days per week with the exception of closed periods near or during commercial fishing periods. The strong return of Chinook and chum salmon allowed many Kuskokwim River tributaries to meet their escapement goals and subsistence users were able to harvest an adequate number of fish.

Historically, Tuluksak River Chinook salmon returns were dominated by age 1.2, 1.3 and 1.4 fish. Similarly, the dominant age groups in 2007 were age 1.2, 1.3, and 1.4, representing 13%, 27%, and 56% of the total escapement (Appendix 5).

Females in previous years (1991 – 1994 and 2002 – 2006) have represented between 14% and 37%, and an average of 26% of the annual runs (Harper 1995a, 1995b, 1995c, 1997; Gates and Harper 2002, 2003; Zabkar and Harper 2004; Zabkar et al. 2006, Plumb et al. 2007). In 2007, escapement of female Chinook salmon was far above average (48%), yet it is important to consider that this number was derived from the lowest Chinook salmon escapement in the history of the Tuluksak River weir.

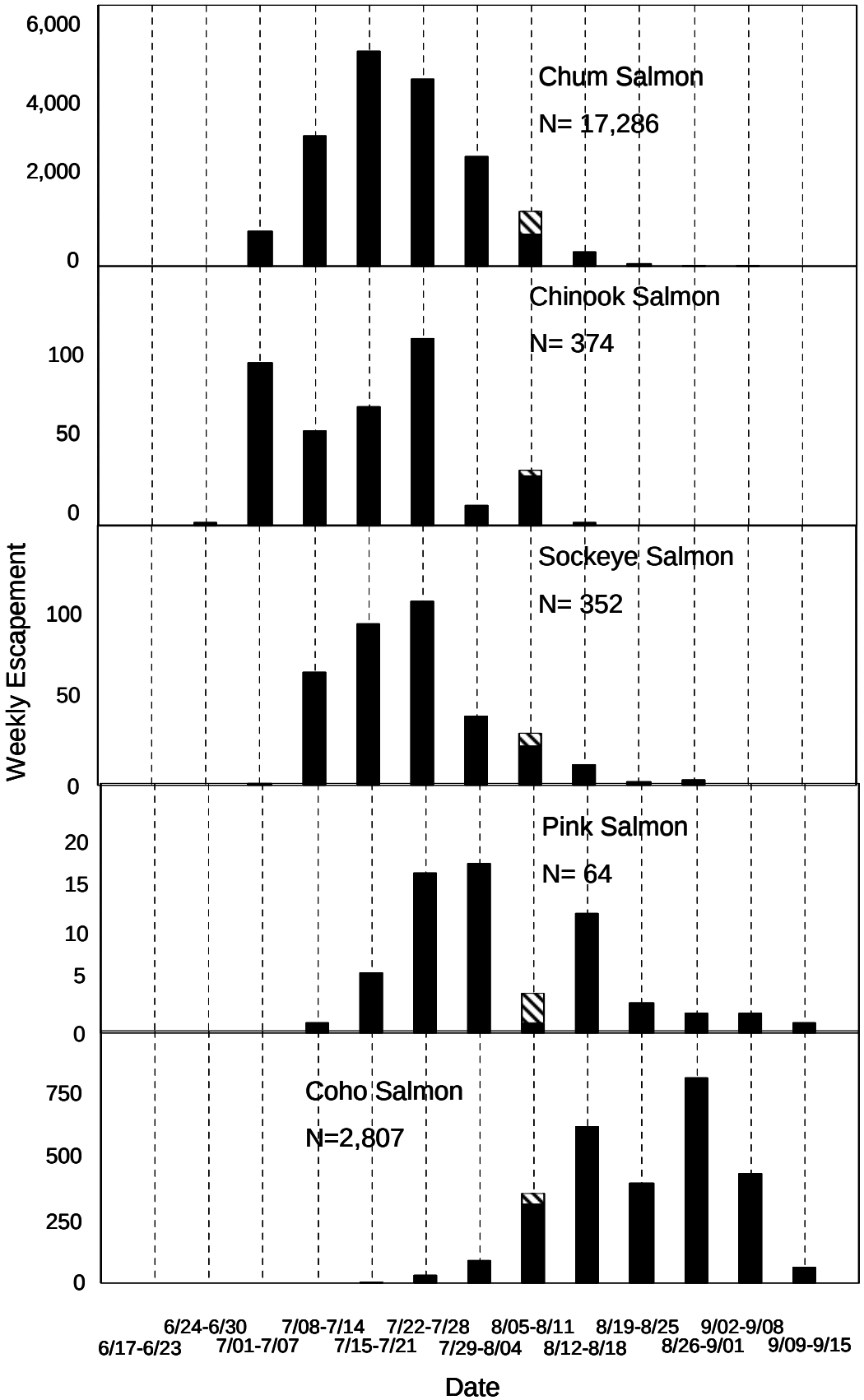

FIGURE 2.—Weekly chum, Chinook, sockeye, pink, and coho salmon escapements through the Tuluksak River weir, 2007. Hash-marked shaded portions of bars represent escapement estimates.

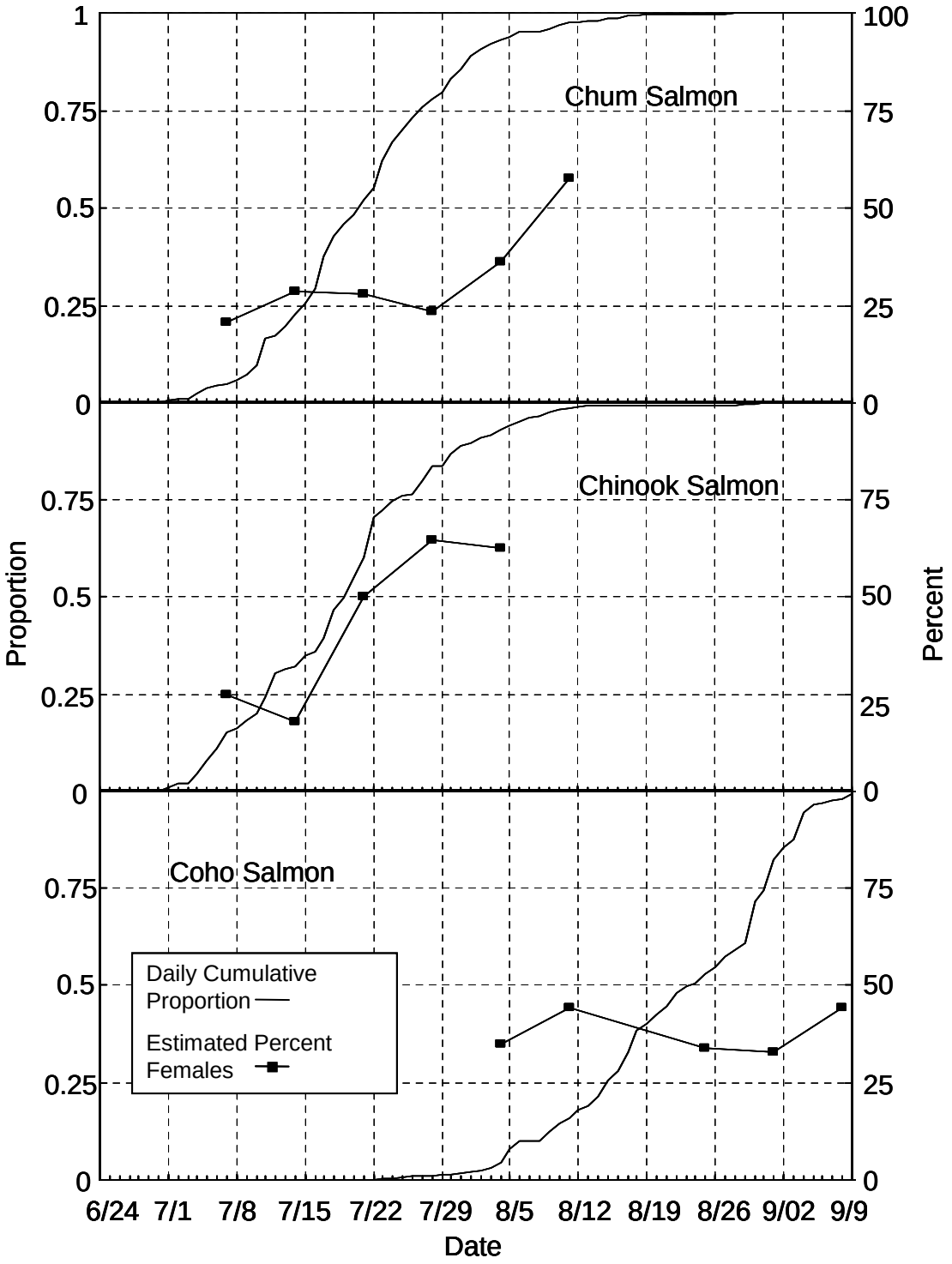

FIGURE 3.—Cumulative proportion and percent females from weekly samples of chum, Chinook, and coho salmon passed through the Tuluksak River weir, 2007.

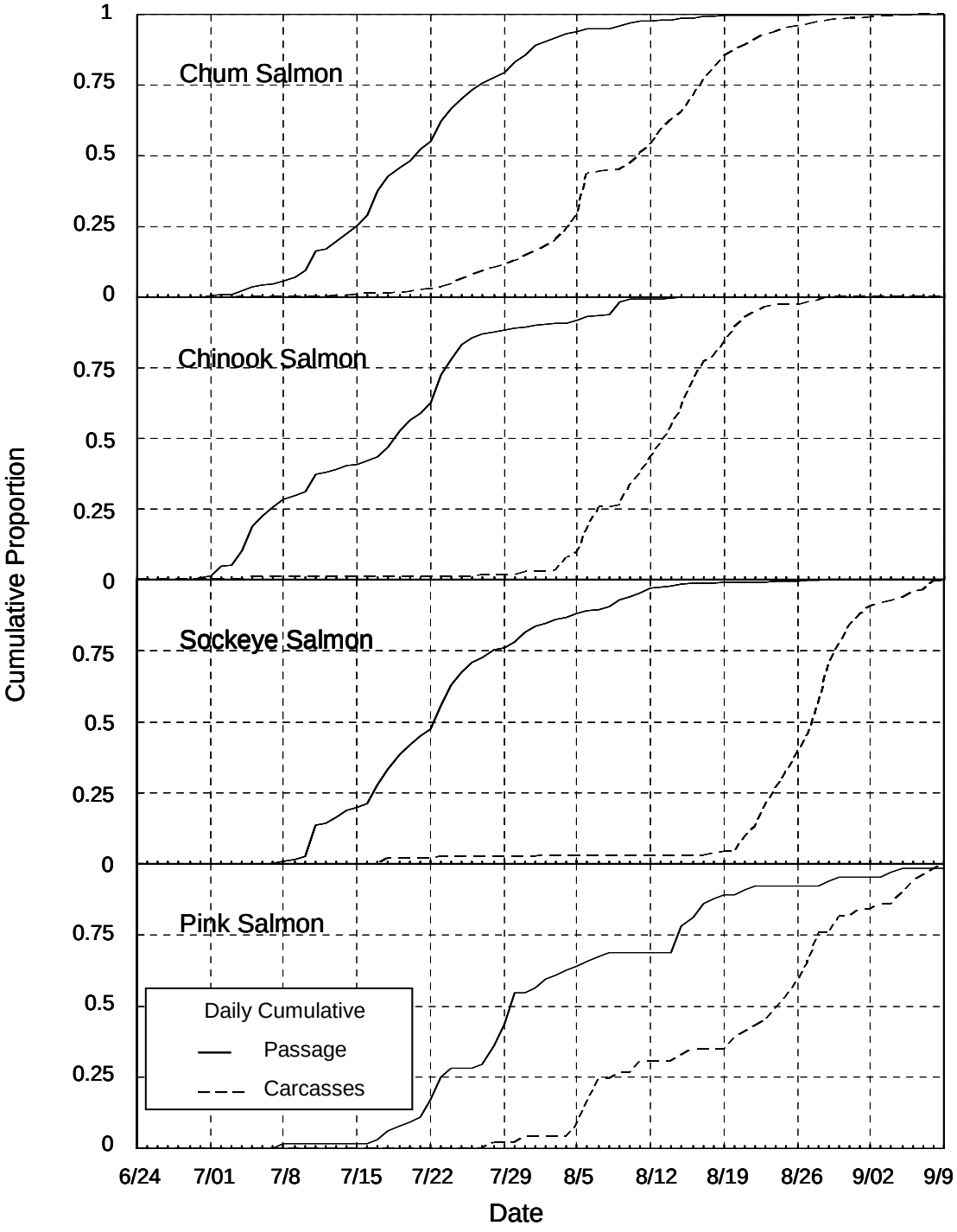

FIGURE 4.—Cumulative proportion of chum, Chinook, sockeye and pink salmon passage and carcasses washing onto the upstream side of the Tuluksak River weir, 2007.

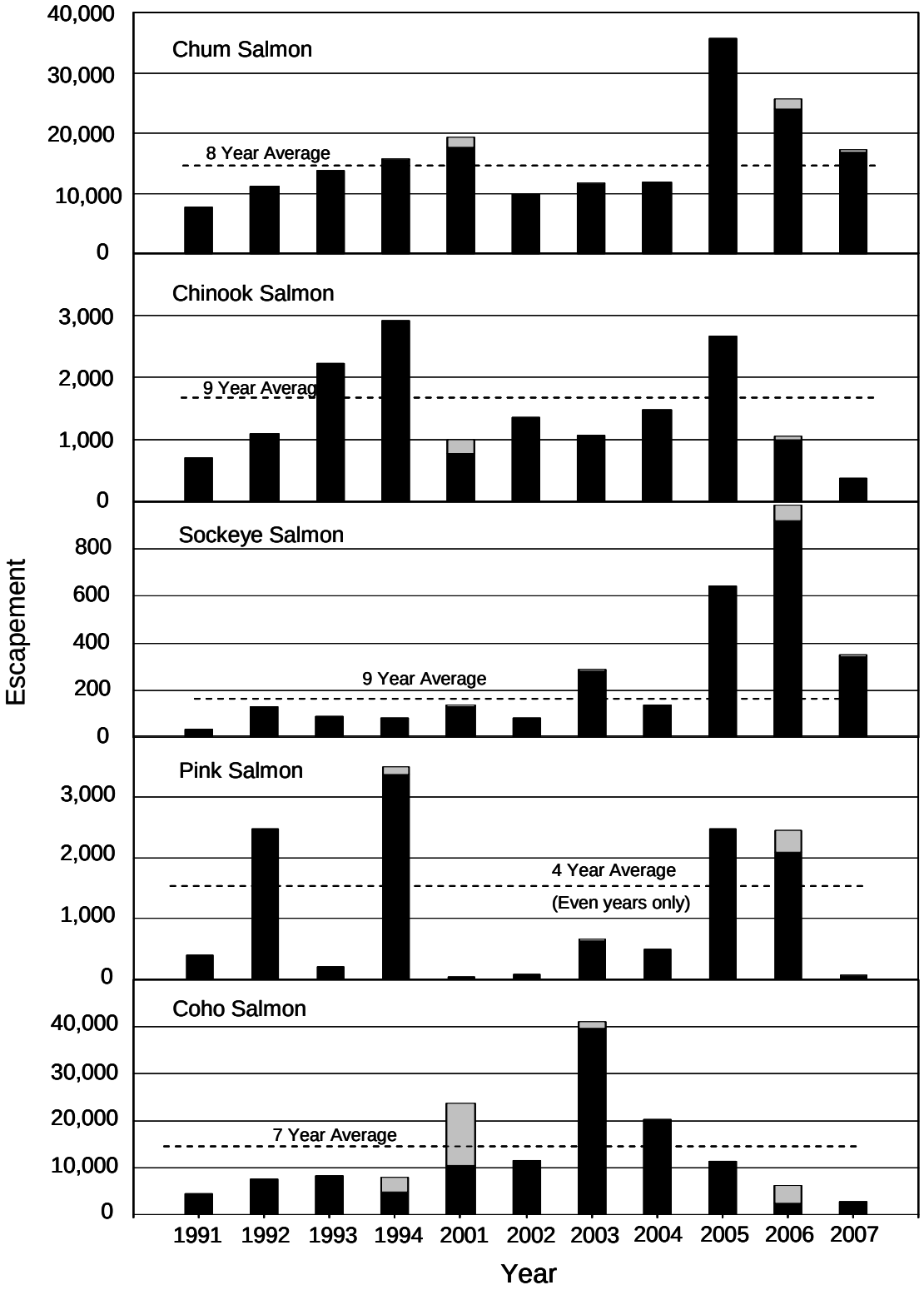

FIGURE 5.—Salmon escapements through the Tuluksak River weir, 1991-1994 and 2001-2007. Note shading for estimated counts. Averages were calculated using only years with complete counts. The y-axis uses different scales.

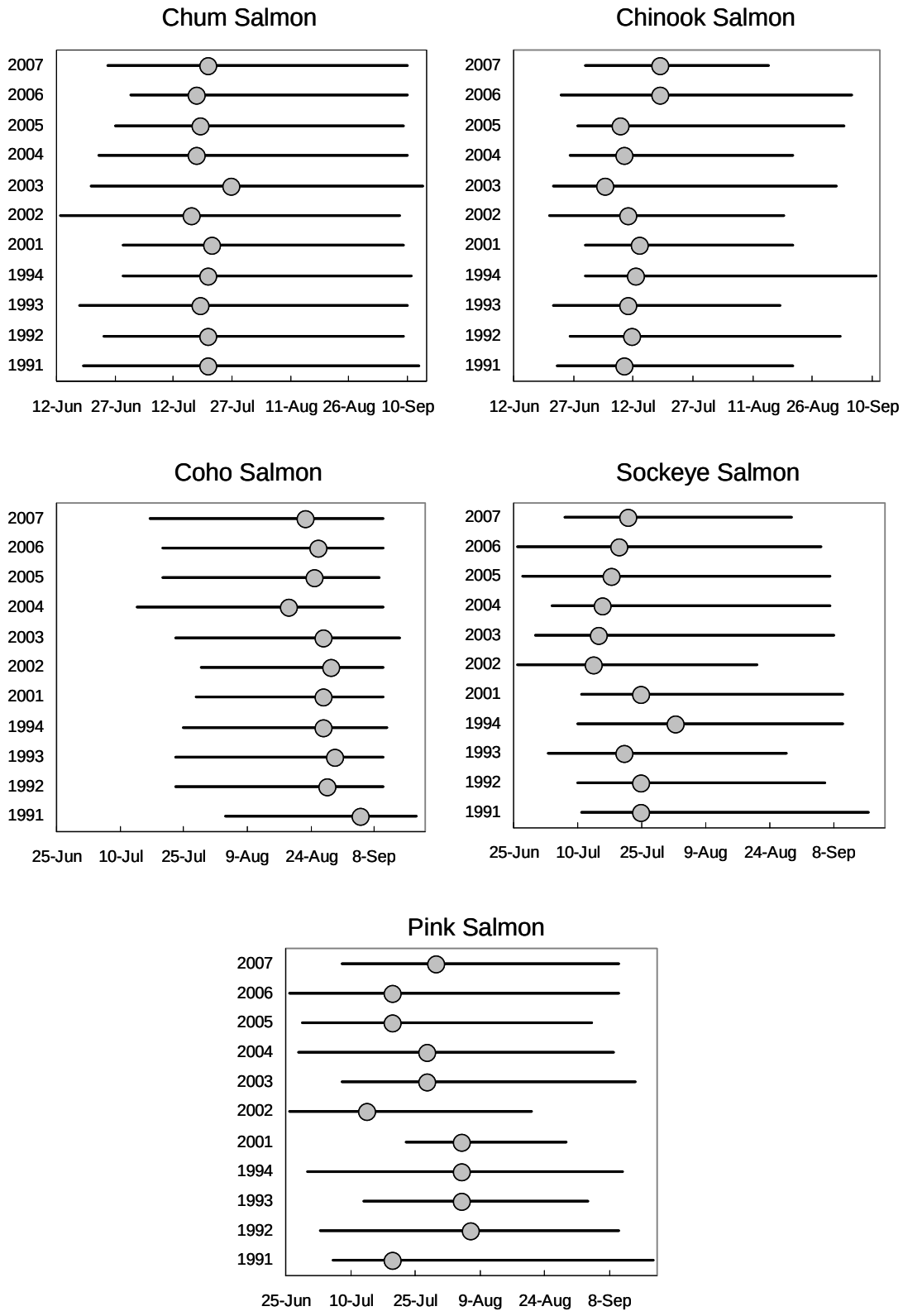

FIGURE 6.—Run timing of chum, Chinook, coho, sockeye, and pink salmon at the Tuluksak River weir, 1991-1994, 2001-2007. For each year, the float indicates date of median cumulative passage and the line represents the date when the salmon were first and last observed at the weir.

Gill net marks (N=20) were observed on 5% of the Chinook salmon that passed the weir. Historically, gill net marks have ranged from 1 to 10% (Harper 1995a, 1995b, 1995c, 1997; Gates and Harper 2002, 2003; Zabkar and Harper 2004; Zabkar et. al 2006, Plumb et al. 2007). Similar to chum salmon, a higher percentage of gill net marks are typically present during years with commercial fishing periods occurring late June and early July (1991 and 1992; 10%) (Harper 1997). In 2007 there was no commercial fishery targeting Chinook salmon in the Kuskokwim River, and the commercial fishing period for coho salmon began on August 1. The data recorded from the Tuluksak River weir indicates that all the gill net marked Chinook salmon escaped upstream before August and, since the majority of the Chinook salmon run occurs before August 1, all gill net marks on the Chinook salmon can be attributed to the subsistence fishery.

Coho Salmon—The 2007 coho salmon escapement estimate was approximately 19% of the historical average. This return was below the past six years of escapement on the Tuluksak River (Figure 5). Similarly, average to below average returns occurred in other Kuskokwim tributaries during 2007. Coho salmon escapement for the Tuluksak and Kwethluk River weirs were the lowest on record. The only exceptions were at the George River weir, which had the second highest escapement on record, and the Kogrukluk River weir escapement was near the higher end of its escapement goal (Linderman 2007).

Run timing in 2007 was average compared to all previous years of weir operations (Figure 6). The estimated median passage date for coho salmon, August 23, was four days before the average, August 27 (Appendix 2). The range of previous year's median passage dates were August 19 to September 5 (Gates and Harper 2003; Zabkar and Harper 2004, Plumb et al. 2007).

Similar to past years, age 2.1 was the dominate age group for 2007, representing an estimated 86% of the escapement. Ages 1.1 and 3.1 were present in the escapement. Age 2.1 has been the primary age group in all years of operations. Compared to previous years, the percentage of female coho salmon (36%) was on the lower end of the range. The range of percent females in past years was 32% to 58% (Harper 1995a, 1995b, 1995c, 1997; Gates and Harper 2002, 2003; Zabkar and Harper 2004; Zabkar et al. 2006, Plumb et al. 2007).

The percentage of gill net marks in the 2007 weir escapement was 1% compared to previous years, 2% to 9% (Harper 1995a, 1995c; Gates and Harper 2003; Zabkar and Harper 2004; Zabkar et. al 2006, Plumb et al. 2007). Coho salmon escapements for 1994, 2001, 2003, and 2006 were estimated; therefore the recorded gill net marks for these years is not an accurate representation. The number of gill net marks has decreased with the decrease of commercial fishing time and harvest of coho salmon. In 2007, twelve commercial fishing periods occurred between August 1 and August 24 for coho salmon. Lower gill net marks may be due in part to the smaller size of the coho salmon, which could have slipped through the gill nets (Linderman and Bue 2006).

Sockeye Salmon—Historically, the total number of sockeye salmon passing the Tuluksak River weir was consistently small (N<150). In 2007, the sockeye salmon escapement (N=352) was the third highest escapement on record (Figure 5). Similarly, other escapement projects located on the Kuskokwim River tributaries had above average sockeye salmon returns. Sockeye salmon returns to the Kogrukluk and Kwethluk River weirs were above average (Linderman 2007).

Fifty percent of the sockeye salmon had passed the weir by July 22, eight days after the earliest median passage date on record. Median passage dates have previously ranged between July 14

and August 1 (Figure 6) (Gates and Harper 2003; Zabkar and Harper 2004; Zabkar et. al 2006, Plumb et al. 2007).

Currently, sockeye salmon are not actively managed in the lower Kuskokwim River commercial fishing districts from the mouth of the Kuskokwim River up to the village of Tuluksak (Ward et al. 2003). The 2007 commercial catch was less than the recent 10-year average harvest of sockeye salmon (Linderman 2007).

Pink Salmon—Kuskokwim River pink salmon typically have strong even-year runs (Francisco et al. 1992). This was observed at the Tuluksak River weir for all even years except 2002 (Figure 5). In 2007, the estimated pink salmon escapement (N=64) returned in very low numbers, below the odd year average escapements (N=758). Pink salmon escapements during previous years of operation have ranged from 27 to 3,374 fish (1991-1994, and 2001-2004). The median passage of July 30 was three days after the average date of July 27 (Figure 6) (Harper 1995b, 1997; Gates and Harper 2003). Currently, pink salmon escapement goals have not been established and very little is known about the Kuskokwim River pink salmon stocks.

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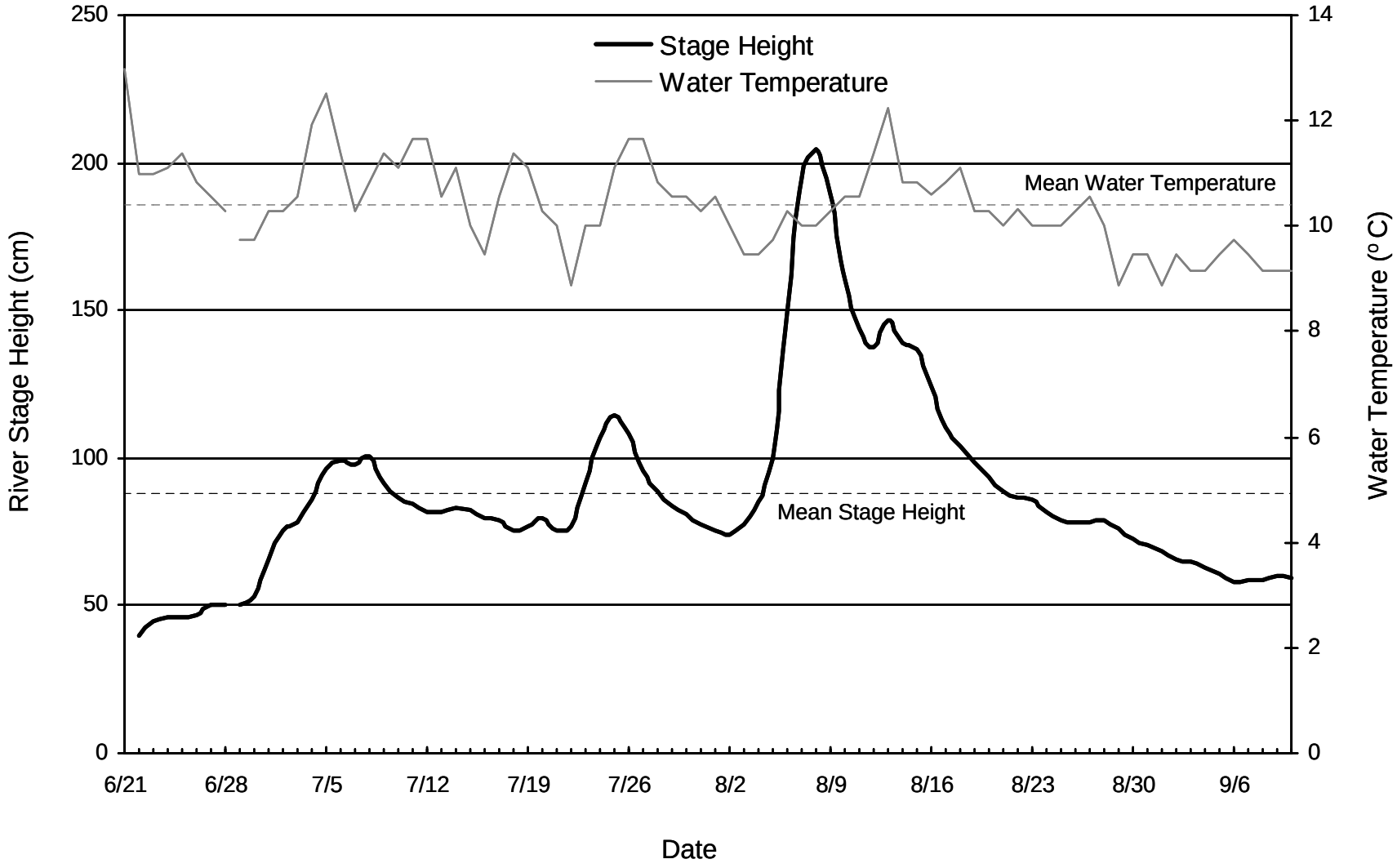

APPENDIX 1.—River stage heights and water temperatures at the Tuluksak River weir, 2007.

APPENDIX 2.—Daily, cumulative, and cumulative proportion of chum, Chinook, sockeye, pink, and coho salmon passing through the Tuluksak River weir, Alaska, 2007.

	Chum Salmon			Chinook Salmon			Sockeye Salmon			Pink Salmon			Coho Salmon		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion
6/20	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/21	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/22	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/23	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/24	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/25	1	1	0.0001	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/26	0	1	0.0001	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/27	0	1	0.0001	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/28	0	1	0.0001	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/29	0	1	0.0001	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
6/30	1	2	0.0001	2	2	0.0053	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/1	89	91	0.0053	3	5	0.0134	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/2	55	146	0.0084	13	18	0.0481	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/3	19	165	0.0095	1	19	0.0508	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/4	216	381	0.0220	20	39	0.1042	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/5	247	628	0.0363	31	70	0.1871	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/6	108	736	0.0426	14	84	0.2245	0	0	0.0000	0	0	0.0000	0	0	0.0000
7/7	65	801	0.0463	12	96	0.2566	1	1	0.0028	0	0	0.0000	0	0	0.0000
7/8	192	993	0.0574	10	106	0.2833	3	4	0.0114	1	1	0.0156	0	0	0.0000
7/9	215	1,208	0.0699	6	112	0.2994	2	6	0.0170	0	1	0.0156	0	0	0.0000
7/10	405	1,613	0.0933	4	116	0.3100	4	10	0.0284	0	1	0.0156	0	0	0.0000
7/11	1,135	2,748	0.1590	24	140	0.3742	38	48	0.1363	0	1	0.0156	0	0	0.0000
7/12	141	2,889	0.1671	2	142	0.3795	3	51	0.1448	0	1	0.0156	0	0	0.0000
7/13	413	3,302	0.1910	4	146	0.3902	7	58	0.1646	0	1	0.0156	0	0	0.0000
7/14	504	3,806	0.2202	5	151	0.4036	8	66	0.1873	0	1	0.0156	0	0	0.0000
7/15	449	4,255	0.2462	1	152	0.4063	4	70	0.1987	0	1	0.0156	0	0	0.0000
7/16	651	4,906	0.2838	6	158	0.4223	5	75	0.2129	0	1	0.0156	0	0	0.0000
7/17	1,396	6,302	0.3646	5	163	0.4357	23	98	0.2782	1	2	0.0313	1	1	0.0004
7/18	876	7,178	0.4153	13	176	0.4704	20	118	0.3350	2	4	0.0625	0	1	0.0004
7/19	538	7,716	0.4464	21	197	0.5265	18	136	0.3860	1	5	0.0781	1	2	0.0007
7/20	391	8,107	0.4690	15	212	0.5666	12	148	0.4201	1	6	0.0938	0	2	0.0007
7/21	648	8,755	0.5065	8	220	0.5880	11	159	0.4513	1	7	0.1094	0	2	0.0007
7/22	481	9,236	0.5343	15	235	0.6281	8	167	0.4740	4	11	0.1719	0	2	0.0007
7/23	1,189	10,425	0.6031	37	272	0.7270	29	196	0.5564	5	16	0.2500	5	7	0.0025
7/24	764	11,189	0.6473	20	292	0.7805	25	221	0.6273	2	18	0.2813	4	11	0.0039

-continued-

APPENDIX 2.—(Page 2 of 3)

	Chum Salmon			Chinook Salmon			Sockeye Salmon			Pink Salmon			Coho Salmon		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion
7/25	555	11,744	0.6794	19	311	0.8312	16	237	0.6727	0	18	0.2813	5	16	0.0057
7/26	530	12,274	0.7101	9	320	0.8553	12	249	0.7068	0	18	0.2813	9	25	0.0089
7/27	429	12,703	0.7349	5	325	0.8687	7	256	0.7267	1	19	0.2969	6	31	0.0110
7/28	351	13,054	0.7552	3	328	0.8767	9	265	0.7522	4	23	0.3594	2	33	0.0118
7/29	280	13,334	0.7714	2	330	0.8820	3	268	0.7607	5	28	0.4375	5	38	0.0135
7/30	611	13,945	0.8067	3	333	0.8901	7	275	0.7806	7	35	0.5469	5	43	0.0153
7/31	386	14,331	0.8291	1	334	0.8927	12	287	0.8147	0	35	0.5469	6	49	0.0175
8/1	571	14,902	0.8621	3	337	0.9007	7	294	0.8345	1	36	0.5625	11	60	0.0214
8/2	273	15,175	0.8779	1	338	0.9034	4	298	0.8459	2	38	0.5938	5	65	0.0232
8/3	231	15,406	0.8913	2	340	0.9088	5	303	0.8601	1	39	0.6094	21	86	0.0306
8/4	182	15,588	0.9018	0	340	0.9088	2	305	0.8658	1	40	0.6250	38	124	0.0442
8/5	141	15,729	0.9100	4	344	0.9195	5	310	0.8800	1	41	0.6406	99	223	0.0795
8/6 *	330	16,059	0.9291	5	349	0.9320	3	313	0.8889	1	42	0.6563	63	286	0.1018
8/7 **	173	16,233	0.9391	1	350	0.9355	2	315	0.8947	1	43	0.6719	13	299	0.1064
8/8 **	152	16,384	0.9479	1	351	0.9372	4	319	0.9048	1	44	0.6875	11	309	0.1102
8/9 *	229	16,614	0.9611	16	367	0.9813	8	326	0.9262	0	44	0.6875	70	380	0.1352
8/10	141	16,755	0.9693	4	371	0.9920	4	330	0.9376	0	44	0.6875	57	437	0.1555
8/11	103	16,858	0.9752	1	372	0.9947	5	335	0.9517	0	44	0.6875	41	478	0.1701
8/12	43	16,901	0.9777	0	372	0.9947	6	341	0.9688	0	44	0.6875	62	540	0.1922
8/13	14	16,915	0.9785	0	372	0.9947	1	342	0.9716	0	44	0.6875	26	566	0.2015
8/14	24	16,939	0.9799	1	373	0.9973	1	343	0.9745	0	44	0.6875	60	626	0.2229
8/15	89	17,028	0.9851	1	374	1.0000	3	346	0.9830	6	50	0.7813	115	741	0.2639
8/16	51	17,079	0.9880	0	374	1.0000	1	347	0.9858	2	52	0.8125	70	811	0.2888
8/17	92	17,171	0.9933	0	374	1.0000	0	347	0.9858	3	55	0.8594	136	947	0.3373
8/18	21	17,192	0.9946	0	374	1.0000	0	347	0.9858	1	56	0.8750	151	1,098	0.3911
8/19	10	17,202	0.9951	0	374	1.0000	1	348	0.9886	1	57	0.8906	44	1,142	0.4067
8/20	8	17,210	0.9956	0	374	1.0000	0	348	0.9886	0	57	0.8906	74	1,216	0.4331
8/21	9	17,219	0.9961	0	374	1.0000	0	348	0.9886	1	58	0.9063	51	1,267	0.4513
8/22	8	17,227	0.9966	0	374	1.0000	0	348	0.9886	1	59	0.9219	97	1,364	0.4858
8/23	9	17,236	0.9971	0	374	1.0000	0	348	0.9886	0	59	0.9219	51	1,415	0.5040
8/24	5	17,241	0.9974	0	374	1.0000	1	349	0.9915	0	59	0.9219	22	1,437	0.5119
8/25	4	17,245	0.9976	0	374	1.0000	0	349	0.9915	0	59	0.9219	59	1,496	0.5329
8/26	10	17,255	0.9982	0	374	1.0000	0	349	0.9915	0	59	0.9219	54	1,550	0.5521
8/27	1	17,256	0.9983	0	374	1.0000	2	351	0.9972	0	59	0.9219	71	1,621	0.5774
8/28	2	17,258	0.9984	0	374	1.0000	0	351	0.9972	0	59	0.9219	48	1,669	0.5945

-continued-

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	Chum Salmon			Chinook Salmon			Sockeye Salmon			Pink Salmon			Coho Salmon		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion	Count	Count	Proportion
8/29	1	17,259	0.9984	0	374	1.0000	1	352	1.0000	1	60	0.9375	50	1,719	0.6123
8/30	3	17,262	0.9986	0	374	1.0000	0	352	1.0000	1	61	0.9531	292	2,011	0.7164
8/31	1	17,263	0.9987	0	374	1.0000	0	352	1.0000	0	61	0.9531	83	2,094	0.7459
9/1	7	17,270	0.9991	0	374	1.0000	0	352	1.0000	0	61	0.9531	217	2,311	0.8233
9/2	2	17,272	0.9992	0	374	1.0000	0	352	1.0000	0	61	0.9531	83	2,394	0.8528
9/3	1	17,273	0.9992	0	374	1.0000	0	352	1.0000	0	61	0.9531	59	2,453	0.8739
9/4	5	17,278	0.9995	0	374	1.0000	0	352	1.0000	1	62	0.9688	196	2,649	0.9437
9/5	2	17,280	0.9997	0	374	1.0000	0	352	1.0000	1	63	0.9844	49	2,698	0.9612
9/6	1	17,281	0.9997	0	374	1.0000	0	352	1.0000	0	63	0.9844	14	2,712	0.9662
9/7	0	17,281	0.9997	0	374	1.0000	0	352	1.0000	0	63	0.9844	19	2,731	0.9729
9/8	0	17,281	0.9997	0	374	1.0000	0	352	1.0000	0	63	0.9844	13	2,744	0.9776
9/9	2	17,283	0.9998	0	374	1.0000	0	352	1.0000	0	63	0.9844	30	2,774	0.9882
9/10	3	17,286	1.0000	0	374	1.0000	0	352	1.0000	1	64	1.0000	33	2,807	1.0000

* Partial counts due to high water.
** No counts due to high water.
Shaded area = Escapement estimate (full or partial days) due to high water event
Boxed areas encompass quartiles (first, median, third).

APPENDIX 3.—Estimated age and sex composition of weekly chum salmon escapements through the Tuluksak River weir, Alaska, 2007, and estimated design effects of the stratified sampling design.

		Brood Year and Age Group					
		2004	2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	0.6	Total
Stratum 1& 2:	06/24 - 07/07						
Sampling Dates:	07/01 - 07/04						
Female:	Number in Sample:	1	25	12	2	0	40
	Estimated % of Escapement:	0.5	13.7	6.6	1.1	0.0	22.0
	Estimated Escapement:	4	110	53	9	0	176
	Standard Error:	3.9	18.0	13.0	5.5	0.0	
Male:	Number in Sample:	0	79	55	8	0	142
	Estimated % of Escapement:	0.0	43.4	30.2	4.4	0.0	78.0
	Estimated Escapement:	0	348	242	35	0	625
	Standard Error:	0.0	25.9	24.0	10.7	0.0	
Total:	Number in Sample:	1	104	67	10	0	182
	Estimated % of Escapement:	0.5	57.1	36.8	5.5	0.0	100.0
	Estimated Escapement:	4	458	295	44	0	801
	Standard Error:	3.9	25.9	25.2	11.9	0.0	
Stratum 3:	07/08 - 07/14						
Sampling Dates:	07/08 - 07/09						
Female:	Number in Sample:	3	31	13	1	0	48
	Estimated % of Escapement:	1.6	16.5	6.9	0.5	0.0	25.5
	Estimated Escapement:	48	496	208	16	0	767
	Standard Error:	26.7	79.0	54.0	15.5	0.0	
Male:	Number in Sample:	0	90	46	4	0	140
	Estimated % of Escapement:	0.0	47.9	24.5	2.1	0.0	74.5
	Estimated Escapement:	0	1,439	735	64	0	2,238
	Standard Error:	0.0	106.3	91.5	30.7	0.0	
Total:	Number in Sample:	3	121	59	5	0	188
	Estimated % of Escapement:	1.6	64.4	31.4	2.7	0.0	100.0
	Estimated Escapement:	48	1,934	943	80	0	3,005
	Standard Error:	26.7	101.9	98.7	34.2	0.0	
Stratum 4:	07/15 - 07/21						
Sampling Dates:	07/15						
Female:	Number in Sample:	6	31	14	1	0	52
	Estimated % of Escapement:	3.4	17.5	7.9	0.6	0.0	29.4
	Estimated Escapement:	168	867	391	28	0	1,454
	Standard Error:	66.3	139.2	98.9	27.5	0.0	
Male:	Number in Sample:	2	96	25	2	0	125
	Estimated % of Escapement:	1.1	54.2	14.1	1.1	0.0	70.6
	Estimated Escapement:	56	2,684	699	56	0	3,495
	Standard Error:	38.7	182.5	127.6	38.7	0.0	
Total:	Number in Sample:	8	127	39	3	0	177
	Estimated % of Escapement:	4.5	71.8	22.0	1.7	0.0	100.0
	Estimated Escapement:	224	3,551	1,090	84	0	4,949
	Standard Error:	76.1	164.9	151.8	47.3	0.0	

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		Brood Year and Age Group					
		2004	2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	0.6	Total
Stratum 5:	07/22 - 07/28						
Sampling Dates:	07/22						
Female:	Number in Sample:	4	30	8	0	0	42
	Estimated % of Escapement:	2.2	16.4	4.4	0.0	0.0	23.0
	Estimated Escapement:	94	705	188	0	0	987
	Standard Error:	45.6	115.4	63.8	0.0	0.0	
Male:	Number in Sample:	4	101	31	5	0	141
	Estimated % of Escapement:	2.2	55.2	16.9	2.7	0.0	77.0
	Estimated Escapement:	94	2,373	728	117	0	3,312
	Standard Error:	45.6	155.1	117.0	50.8	0.0	
Total:	Number in Sample:	8	131	39	5	0	183
	Estimated % of Escapement:	4.4	71.6	21.3	2.7	0.0	100.0
	Estimated Escapement:	188	3,077	916	117	0	4,299
	Standard Error:	63.8	140.6	127.7	50.8	0.0	
Stratam 6:	07/29 - 08/04						
Sampling Dates:	07/29 - 07/30						
Female:	Number in Sample:	3	58	9	1	0	71
	Estimated % of Escapement:	1.6	31.4	4.9	0.5	0.0	38.4
	Estimated Escapement:	41	794	123	14	0	973
	Standard Error:	22.7	83.4	38.7	13.2	0.0	
Male:	Number in Sample:	0	93	19	2	0	114
	Estimated % of Escapement:	0.0	50.3	10.3	1.1	0.0	61.6
	Estimated Escapement:	0	1,274	260	27	0	1,561
	Standard Error:	0.0	89.9	54.6	18.6	0.0	
Total:	Number in Sample:	3	151	28	3	0	185
	Estimated % of Escapement:	1.6	81.6	15.1	1.6	0.0	100.0
	Estimated Escapement:	41	2,068	384	41	0	2,534
	Standard Error:	22.7	69.7	64.5	22.7	0.0	
Stratum: 7 - 12	08/05 - 09/10						
Sampling Dates:	08/05						
Female:	Number in Sample:	1	60	2	0	0	63
	Estimated % of Escapement:	0.9	55.6	1.9	0.0	0.0	58.3
	Estimated Escapement:	16	943	31	0	0	991
	Standard Error:	15.2	78.9	21.4	0.0	0.0	
Male:	Number in Sample:	1	35	8	1	0	45
	Estimated % of Escapement:	0.9	32.4	7.4	0.9	0.0	41.7
	Estimated Escapement:	16	550	126	16	0	708
	Standard Error:	15.2	74.3	41.6	15.2	0.0	
Total:	Number in Sample:	2	95	10	1	0	108
	Estimated % of Escapement:	1.9	88.0	9.3	0.9	0.0	100.0
	Estimated Escapement:	31	1,494	157	16	0	1,698
	Standard Error:	21.4	51.7	46.0	15.2	0.0	

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		Brood Year and Age Group					
		2004	2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	0.6	Total
Strata 1 - 12:	06/24 - 09/10						
Sampling Dates:	07/01 - 08/05						
Female:	Number in Sample:	18	235	58	5	0	316
	% Females in Age Group:	6.9	73.2	18.6	1.2	0.0	100.0
	Estimated % of Escapement:	2.1	22.6	5.8	0.4	0.0	30.9
	Estimated Escapement:	371	3,915	995	66	0	5,347
	Standard Error:	89.1	229.0	137.4	34.6	0.0	
	Estimated Design Effects:	1.354	1.079	1.250	1.129	0.000	1.143
Male:	Number in Sample:	7	494	184	22	0	707
	% Males in Age Group:	1.4	72.6	23.4	2.6	0.0	100.0
	Estimated % of Escapement:	1.0	50.1	16.1	1.8	0.0	69.1
	Estimated Escapement:	166	8,667	2,791	316	0	11,939
	Standard Error:	61.7	288.0	208.8	75.6	0.0	
	Estimated Design Effects:	1.432	1.193	1.160	1.150	0.000	1.143
Total:	Number in Sample:	25	729	242	27	0	1,023
	Estimated % of Escapement:	3.1	72.8	21.9	2.2	0.0	100.0
	Estimated Escapement:	537	12,582	3,785	382	0	17,286 *
	Standard Error:	107.5	256.0	236.7	83.0	0.0	
	Estimated Design Effects:	1.373	1.190	1.178	1.148	0.000	

* Escapement estimates were used in the calculation of the total number of chum salmon. Estimates were made from 08/6 - 08/9.

APPENDIX 4.—Estimated length at age composition of weekly chum salmon escapements through the Tuluksak River weir, Alaska, 2007.

		Brood Year and Age Group				
		2004	2003	2002	2001	2000
		0.2	0.3	0.4	0.5	0.6
Stratum 1 & 2:	06/24 - 07/07					
Sampling Dates:	07/01 - 07/04					
Male:	Mean Length		580	590	608	
	Std. Error		3	3	7	
	Range		510- 640	540- 640	575- 625	
	Sample Size	0	79	55	8	0
Female:	Mean Length	540	560	555	590	
	Std. Error		5	5	20	
	Range	540- 540	500- 600	530- 580	570- 610	
	Sample Size	1	25	12	2	0
Stratum 3:	07/08 - 07/14					
Sampling Dates:	07/08 - 07/09					
Male:	Mean Length		571	589	584	
	Std. Error		3	5	17	
	Range		490- 650	490- 670	560- 635	
	Sample Size	0	90	46	4	0
Female:	Mean Length	547	543	566	575	
	Std. Error	6	6	5		
	Range	535- 555	480- 610	530- 590	575- 575	
	Sample Size	3	31	13	1	0
Stratum 4:	07/15 - 07/21					
Sampling Dates:	07/15					
Male:	Mean Length	548	559	571	588	
	Std. Error	13	2	5	3	
	Range	535- 560	500- 630	515- 635	585- 590	
	Sample Size	2	96	25	2	0
Female:	Mean Length	526	532	551	570	
	Std. Error	12	4	8	.	
	Range	480- 555	500- 585	485- 590	570- 570	
	Sample Size	6	31	14	1	0
Stratum 5:	07/22 - 07/28					
Sampling Dates:	07/22					
Male:	Mean Length	550	557	579	575	
	Std. Error	11	3	5	14	
	Range	520- 570	470- 650	515- 650	545- 610	
	Sample Size	4	101	31	5	0
Female:	Mean Length	539	530	524		
	Std. Error	7	6	10		
	Range	520- 550	470- 600	490- 565		
	Sample Size	4	30	8	0	0
Stratum 6:	07/29 - 08/04					
Sampling Dates:	07/29 - 07/30					
Male:	Mean Length		555	563	558	
	Std. Error		3	8	3	
	Range		490- 620	515- 625	555- 560	
	Sample Size	0	93	19	2	0
Female:	Mean Length	520	531	534	555	
	Std. Error	9	4	10	.	
	Range	505- 535	425- 590	470- 575	555- 555	
	Sample Size	3	58	9	1	0

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		Brood Year and Age Group				
		2004	2003	2002	2001	2000
		0.2	0.3	0.4	0.5	0.6
Stratum: 7 - 12	08/05 - 09/10					
Sampling Dates:	08/05					
Male:	Mean Length	550	549	549	550	
	Std. Error		6	19		
	Range	550- 550	470- 630	470- 640	550- 550	
	Sample Size	1	35	8	1	0
Female:	Mean Length	500	519	520		
	Std. Error		4	10		
	Range	500- 500	450- 590	510- 530		
	Sample Size	1	60	2	0	0
Strata 1 - 12:	06/24 - 09/10					
Sampling Dates:	07/01 - 08/05					
Male:	Mean Length	549	561	578	580	
	Std. Error	8	1	3	7	
	Range	520- 570	470- 650	470- 670	545- 635	
	Sample Size	7	494	184	22	0
Female:	Mean Length	531	532	546	571	
	Std. Error	6	2	4	20	
	Range	480- 555	425- 610	470- 590	555- 610	
	Sample Size	18	235	58	5	0

APPENDIX 5.—Estimated age and sex composition of weekly Chinook salmon escapements through the Tuluksak River weir, Alaska, 2007, and estimated design effects of the stratified sampling design.

		Brood Year and Age Group					
		2004	2003	2002	2001	2000	
		1.1	1.2	1.3	1.4	1.5	Total
Stratum 1& 2:	06/24 - 07/07						
Sampling Dates:	06/30 - 07/07						
Female:	Number in Sample:	1	0	2	10	0	13
	Estimated % of Escapement:	2.3	0.0	4.5	22.7	0.0	29.5
	Estimated Escapement:	2	0	4	22	0	28
	Standard Error:	1.6	0.0	2.2	4.5	0.0	
Male:	Number in Sample:	0	8	11	12	0	31
	Estimated % of Escapement:	0.0	18.2	25.0	27.3	0.0	70.5
	Estimated Escapement:	0	17	24	26	0	68
	Standard Error:	0.0	4.2	4.7	4.8	0.0	
Total:	Number in Sample:	1	8	13	22	0	44
	Estimated % of Escapement:	2.3	18.2	29.5	50.0	0.0	100.0
	Estimated Escapement:	2	17	28	48	0	96
	Standard Error:	1.6	4.2	4.9	5.4	0.0	
Stratum 3 & 4:	07/08 - 07/21						
Sampling Dates:	07/08 - 07/14, 07/16 - 07/21						
Female:	Number in Sample:	0	3	5	22	1	31
	Estimated % of Escapement:	0.0	3.9	6.6	28.9	1.3	40.8
	Estimated Escapement:	0	5	8	36	2	51
	Standard Error:	0.0	1.7	2.2	4.0	1.0	
Male:	Number in Sample:	1	9	21	13	1	45
	Estimated % of Escapement:	1.3	11.8	27.6	17.1	1.3	59.2
	Estimated Escapement:	2	15	34	21	2	73
	Standard Error:	1.0	2.9	4.0	3.4	1.0	
Total:	Number in Sample:	1	12	26	35	2	76
	Estimated % of Escapement:	1.3	15.8	34.2	46.1	2.6	100.0
	Estimated Escapement:	2	20	42	57	3	124
	Standard Error:	1.0	3.2	4.2	4.4	1.4	
Stratum 5, 6, & 7:	07/22 - 08/11						
Sampling Dates:	07/22 - 07/29, 07/31 - 08/03, 08/05						
Female:	Number in Sample:	0	0	3	44	4	51
	Estimated % of Escapement:	0.0	0.0	3.9	57.1	5.2	66.2
	Estimated Escapement:	0	0	6	88	8	102
	Standard Error:	0.0	0.0	2.4	6.2	2.8	
Male:	Number in Sample:	0	6	12	8	0	26
	Estimated % of Escapement:	0.0	7.8	15.6	10.4	0.0	33.8
	Estimated Escapement:	0	12	24	16	0	52
	Standard Error:	0.0	3.3	4.5	3.8	0.0	
Total:	Number in Sample:	0	6	15	52	4	77
	Estimated % of Escapement:	0.0	7.8	19.5	67.5	5.2	100.0
	Estimated Escapement:	0	12	30	104	8	154
	Standard Error:	0.0	3.3	4.9	5.8	2.8	

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		Brood Year and Age Group					
		2004	2003	2002	2001	2000	
		1.1	1.2	1.3	1.4	1.5	Total
Stratum 8 - 12:	08/12 - 09/10						
No Samples Collected							
Strata 1 - 12:	06/24 - 09/10						
Sampling Dates:	06/30 - 08/05						
Female:	Number in Sample:	1	3	10	76	5	95
	% Females in Age Group:	1.2	2.7	10.2	80.5	5.3	100.0
	Estimated % of Escapement:	0.6	1.3	4.9	38.8	2.6	48.1
	Estimated Escapement:	2	5	19	146	10	181
	Standard Error:	1.6	1.7	4.0	8.7	3.0	
	Estimated Design Effects:	1.144	0.839	0.994	0.913	1.001	0.910
Male:	Number in Sample:	1	23	44	33	1	102
	% Males in Age Group:	0.8	22.9	42.6	32.8	0.8	100.0
	Estimated % of Escapement:	0.4	11.7	21.9	16.9	0.4	51.3
	Estimated Escapement:	2	44	82	63	2	193
	Standard Error:	1.0	6.1	7.6	7.0	1.0	
	Estimated Design Effects:	0.854	1.013	0.991	0.995	0.854	0.910
Total:	Number in Sample:	2	26	54	109	6	197
	Estimated % of Escapement:	1.0	13.0	26.8	55.6	3.0	99.5
	Estimated Escapement:	4	49	101	209	11	374 *
	Standard Error:	1.9	6.2	8.2	9.1	3.1	
	Estimated Design Effects:	1.025	0.997	0.987	0.971	0.984	

* Escapement estimates were used in the calculation of the total number of Chinook salmon. Estimates were made from 08/6 - 08/9.

APPENDIX 6.—Estimated length at age composition of weekly Chinook salmon escapements through the Tuluksak River weir, Alaska, 2007.

		Brood Year and Age Group				
		2004	2003	2002	2001	2000
		1.1	1.2	1.3	1.4	1.5
Stratum 1 & 2:	06/24 - 07/07					
Sampling Dates:	06/30 - 07/07					
Male:	Mean Length		522	690	784	
	Std. Error		19	10	33	
	Range		440- 620	640- 760	625- 970	
	Sample Size	0	8	11	12	0
Female:	Mean Length	370		785	842	
	Std. Error				24	
	Range	370- 370		785- 785	700- 920	
	Sample Size	1	0	1	10	0
Stratum 3 & 4:	07/08 - 07/21					
Sampling Dates:	07/08 - 07/14, 07/16 - 07/21					
Male:	Mean Length	350	546	688	785	
	Std. Error		16	14	31	
	Range	350- 350	480- 620	570- 800	675-1100	
	Sample Size	1	9	21	13	0
Female:	Mean Length		528	784	873	890
	Std. Error		24	14	13	
	Range		500- 575	740- 820	755- 960	890- 890
	Sample Size	0	3	5	22	1
Stratum 5, 6, & 7:	07/22-08/11					
Sampling Dates:	07/22 - 07/29, 07/31 - 08/03, 08/05					
Male:	Mean Length		507	697	804	
	Std. Error		16	10	27	
	Range		460- 560	650- 760	740- 935	
	Sample Size	0	6	12	8	0
Female:	Mean Length			768	860	885
	Std. Error			20	6	6
	Range			730- 800	770- 950	870- 900
	Sample Size	0	0	3	44	4
Strata 8 - 12:	08/12 - 09/10					
No Samples Collected						
Strata 1 - 12:	06/24 - 09/10					
Sampling Dates:	06/30 - 08/05					
Male:	Mean Length	350	527	691	789	
	Std. Error		10	7	19	
	Range	350- 350	440- 620	570- 800	625-1100	
	Sample Size	1	23	44	33	0
Female:	Mean Length	370	528	780	861	886
	Std. Error		24	9	6	6
	Range	370- 370	500- 575	730- 820	700- 960	870- 900
	Sample Size	1	3	9	76	5

APPENDIX 7.—Estimated age and sex composition of weekly coho salmon escapements through the Tuluksak River weir, Alaska, 2007, and estimated design effects of the stratified sampling design.

		Brood Year and Age Group				
		2004	2003	2002	2001	
		1.1	2.1	3.1	4.1	Total
Stratum 1 - 3:	06/24 - 07/14					
No Samples Collected						
Stratum 4 - 8:	07/15 - 08/18					
Sampling Dates:	07/17, 07/19, 07/25, 07/29 - 08/05					
Female:	Number in Sample:	5	42	1	0	48
	Estimated % of Escapement:	3.8	31.8	0.8	0.0	36.4
	Estimated Escapement:	42	349	8	0	399
	Standard Error:	17.2	41.9	7.8	0.0	
Male:	Number in Sample:	8	74	2	0	84
	Estimated % of Escapement:	6.1	56.1	1.5	0.0	63.6
	Estimated Escapement:	67	616	17	0	699
	Standard Error:	21.5	44.7	11.0	0.0	
Total:	Number in Sample:	13	116	3	0	132
	Estimated % of Escapement:	9.8	87.9	2.3	0.0	100.0
	Estimated Escapement:	108	965	25	0	1,098
	Standard Error:	26.8	29.4	13.4	0.0	
Stratum 9:	08/19 - 08/25					
Sampling Dates:	08/19 - 08/22					
Female:	Number in Sample:	4	40	2	0	46
	Estimated % of Escapement:	2.6	26.5	1.3	0.0	30.5
	Estimated Escapement:	11	105	5	0	121
	Standard Error:	4.1	11.3	2.9	0.0	
Male:	Number in Sample:	7	92	6	0	105
	Estimated % of Escapement:	4.6	60.9	4.0	0.0	69.5
	Estimated Escapement:	18	242	16	0	277
	Standard Error:	5.4	12.5	5.0	0.0	
Total:	Number in Sample:	11	132	8	0	151
	Estimated % of Escapement:	7.3	87.4	5.3	0.0	100.0
	Estimated Escapement:	29	348	21	0	398
	Standard Error:	6.7	8.5	5.7	0.0	
Stratum 10:	08/26 - 09/01					
Sampling Dates:	08/26 - 08/29					
Female:	Number in Sample:	4	39	3	0	46
	Estimated % of Escapement:	2.8	27.5	2.1	0.0	32.4
	Estimated Escapement:	23	224	17	0	264
	Standard Error:	10.3	27.8	9.0	0.0	
Male:	Number in Sample:	13	78	5	0	96
	Estimated % of Escapement:	9.2	54.9	3.5	0.0	67.6
	Estimated Escapement:	75	448	29	0	551
	Standard Error:	18.0	31.0	11.5	0.0	
Total:	Number in Sample:	17	117	8	0	142
	Estimated % of Escapement:	12.0	82.4	5.6	0.0	100.0
	Estimated Escapement:	98	672	46	0	815
	Standard Error:	20.2	23.8	14.4	0.0	

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		Brood Year and Age Group				
		2004	2003	2002	2001	
		1.1	2.1	3.1	4.1	Total
Stratum 11 & 12: 09/02 - 09/08						
Sampling Dates: 09/02 - 09/04						
Female:	Number in Sample:	3	53	5	0	61
	Estimated % of Escapement:	2.2	38.1	3.6	0.0	43.9
	Estimated Escapement:	11	189	18	0	218
	Standard Error:	5.2	17.4	6.7	0.0	
Male:	Number in Sample:	7	67	4	0	78
	Estimated % of Escapement:	5.0	48.2	2.9	0.0	56.1
	Estimated Escapement:	25	239	14	0	278
	Standard Error:	7.8	17.9	6.0	0.0	
Total:	Number in Sample:	10	120	9	0	139
	Estimated % of Escapement:	7.2	86.3	6.5	0.0	100.0
	Estimated Escapement:	36	428	32	0	496
	Standard Error:	9.3	12.3	8.8	0.0	
Strata 1 - 12: 06/24 - 09/10						
Sampling Dates: 07/17 - 09/04						
Female:	Number in Sample:	16	174	11	0	201
	% Females in Age Group:	8.6	86.6	4.9	0.0	100.0
	Estimated % of Escapement:	3.1	30.9	1.7	0.0	35.7
	Estimated Escapement:	86	868	49	0	1,002
	Standard Error:	21.1	54.4	13.9	0.0	
	Estimated Design Effects:	1.276	1.191	1.016	0.000	1.190
Male:	Number in Sample:	35	311	17	0	363
	% Males in Age Group:	10.2	85.6	4.2	0.0	100.0
	Estimated % of Escapement:	6.6	55.0	2.7	0.0	64.3
	Estimated Escapement:	185	1,545	75	0	1,805
	Standard Error:	29.6	58.6	17.7	0.0	
	Estimated Design Effects:	1.219	1.192	1.059	0.000	1.190
Total:	Number in Sample:	51	485	28	0	564
	Estimated % of Escapement:	9.6	85.9	4.4	0.0	100.0
	Estimated Escapement:	270	2,413	124	0	2,807 *
	Standard Error:	35.5	40.6	22.3	0.0	
	Estimated Design Effects:	1.235	1.177	1.042	0.000	

* Escapement estimates were used in the calculation of the total number of coho salmon. Estimates were made from 08/6 - 08/9.

APPENDIX 8.—Estimated length at age composition of weekly coho salmon escapements through the Tuluksak River weir, Alaska, 2007.

		Brood Year and Age Group		
		2004	2003	2002
		1.1	2.1	3.1
Stratum 1 - 3:	06/24 - 07/14			
No Samples Collected				
Stratum 4 - 8:	07/05 - 08/18			
Sampling Dates:	07/17, 07/19, 07/25, 07/29 - 08/05			
Male:	Mean Length	539	535	575
	Std. Error	5	5	15
	Range	520- 560	425- 590	560- 590
	Sample Size	8	74	2
Female:	Mean Length	527	531	565
	Std. Error	17	6	.
	Range	480- 560	415- 600	565- 565
	Sample Size	5	42	1
Stratum 9:	08/19 - 08/25			
Sampling Dates:	08/19 - 08/22			
Male:	Mean Length	547	562	573
	Std. Error	5	4	16
	Range	525- 560	430- 620	525- 630
	Sample Size	7	92	6
Female:	Mean Length	551	541	570
	Std. Error	10	6	5
	Range	535- 580	430- 610	565- 575
	Sample Size	4	40	2
Stratum 10:	08/26 - 09/01			
Sampling Dates:	08/26 - 08/29			
Male:	Mean Length	570	575	584
	Std. Error	7	4	8
	Range	540- 615	445- 650	560- 610
	Sample Size	13	78	5
Female:	Mean Length	569	551	562
	Std. Error	8	6	25
	Range	550- 585	450- 605	515- 600
	Sample Size	4	39	3
Stratum 11 & 12:	09/02 - 09/08			
Sampling Dates:	09/02 - 09/04			
Male:	Mean Length	559	562	578
	Std. Error	13	6	13
	Range	510- 610	400- 650	540- 600
	Sample Size	7	67	4
Female:	Mean Length	568	547	547
	Std. Error	6	4	19
	Range	560- 580	460- 595	510- 595
	Sample Size	3	53	5

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		Brood Year and Age Group		
		2004	2003	2002
		1.1	2.1	3.1
Strata 1 - 12:	06/24 - 09/10			
Sampling Dates:	07/17 - 09/04			
Male:	Mean Length	556	559	577
	Std. Error	4	2	7
	Range	510- 615	400- 650	525- 630
	Sample Size	35	311	17
Female:	Mean Length	551	542	557
	Std. Error	6	3	12
	Range	480- 585	415- 610	510- 600
	Sample Size	16	174	11

APPENDIX 9.—Estimated age and sex composition of weekly sockeye salmon escapements through the Tuluksak River weir, Alaska, 2007, and estimated design effects of the stratified sampling design.

		Brood Year and Age Group				
		2003	2002	2001	2000	
		1.2	1.3	1.4	2.3	Total
Stratum 1 - 12:	06/24 - 09/10					
Sampling Dates:	07/0/8 - 07/19					
Female:	Number in Sample:	2	23	0	1	26
	% Females in Age Group:	7.7	88.5	0.0	3.8	100.0
	Estimated % of Escapement:	3.1	35.4	0.0	1.5	40.0
	Estimated Escapement:	11	125	0	5	141
	Standard Error:	6.9	19.0	0.0	4.9	
	Estimated Design Effects:	1.000	1.000	0.000	1.000	1.000
Male:	Number in Sample:	12	26	1	0	39
	% Males in Age Group:	30.8	66.7	2.6	0.0	100.0
	Estimated % of Escapement:	18.5	40.0	1.5	0.0	60.0
	Estimated Escapement:	65	141	5	0	211
	Standard Error:	15.4	19.5	4.9	0.0	
	Estimated Design Effects:	1.000	1.000	1.000	0.000	1.000
Total:	Number in Sample:	14	49	1	1	65
	Estimated % of Escapement:	21.5	75.4	1.5	1.5	100.0
	Estimated Escapement:	76	265	5	5	352 *
	Standard Error:	16.3	17.1	4.9	4.9	
	Estimated Design Effects:	1.000	1.000	1.000	1.000	

* Escapement estimates were used in the calculation of the total number of sockeye salmon. Estimates were made from 08/6 - 08/9.

APPENDIX 10.—Estimated length at age composition of weekly sockeye salmon escapements through the Tuluksak River weir, Alaska, 2007.

		Brood Year and Age Group			
		2003	2002	2001	2000
		1.2	1.3	1.4	2.3
Strata 1 - 12:	06/24 - 09/10				
Sampling Dates:	07/08 - 07/19				
Male:	Mean Length	563	583	625	
	Std. Error	6	4		
	Range	535 - 595	540 - 615	625 - 625	
	Sample Size	12	26	1	0
Female:	Mean Length	518	532		560
	Std. Error	18	6		
	Range	500 - 535	460 - 600		560 - 560
	Sample Size	2	23	0	1