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

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Steve J. Miller, Ken C. Harper, and Chad Whaley

Abstract

The U.S. Fish and Wildlife Service, assisted by the Organized Village of Kwethluk, operated a resistance board weir on the Kwethluk River, a tributary to the lower Kuskokwim River, between June 24 and September 10, 2007. Data collected were used for in-season management of the commercial and subsistence fisheries in the Kuskokwim drainage. Counts of 54,913 chum *Oncorhynchus keta*, 12,927 Chinook *O. tshawytscha*, 5,148 sockeye *O. nerka*, 626 pink *O. gorbuscha*, and 19,473 coho *O. kisutch* salmon were documented through the weir. Peak weekly passage occurred July 8 to14 for chum and Chinook, July 1 to 7 for sockeye, July 22 to 28 for pink, and August 19 to 25 for coho salmon. Age, sex, and length data were collected for each species except pink salmon. Dominant age classes were 0.3 for chum, 1.4 for female and 1.2 for male Chinook, 1.3 for sockeye, and 2.1 for coho salmon. Over all percentages for female salmon were chum 45%, Chinook 26%, sockeye 49%, and coho 38%.

Introduction

The Kwethluk River, a lower Kuskokwim River tributary located on the Yukon Delta National Wildlife Refuge (Refuge), provides important spawning and rearing habitat for chum *Oncorhynchus keta*, Chinook *O. tshawytscha*, sockeye *O. nerka*, pink *O. gorbuscha*, and coho *O. kisutch* salmon (Figure 1) (Alt 1977; U.S. Fish and Wildlife Service 1992). Adult salmon returning to the Kwethluk River migrate 130 river kilometers (rkm) through the lower Kuskokwim River and up to an additional 160 rkm in the Kwethluk River before reaching spawning grounds. In the lower Kuskokwim River, salmon pass through one of Alaska's most intensive subsistence fisheries (Burkey et al. 2001; U.S. Fish and Wildlife Service 1988). In general, half of the total Chinook salmon statewide subsistence harvest occurs in the Kuskokwim drainage (Alaska Department Fish and Game 2001, 2002, 2003a, 2003b).

The Alaska National Interest Lands Conservation Act (ANILCA) mandates that salmon populations and their habitats be conserved in their natural diversity within federal lands; that international treaty obligations are fulfilled; and subsistence opportunities for local residents be maintained. Salmon escapement studies for the Kuskokwim River tributaries on the Refuge are priorities in the Refuge Fishery Management Plan (U.S. Fish and Wildlife Service 1992). However, management of these mixed species systems of multiple individual stocks is not straight forward. Escapement and run timing, as well as other data, are required to meet these policies, mandates, and regulations and provide for sound management strategies and practices.

Under guidelines established in the State of Alaska's sustainable salmon fisheries policy 5AAC.39.222, the Alaska Board of Fisheries (Board) designated Kuskokwim River chum and Chinook salmon stocks as yield concerns in 2001 and managed the fishery under those guidelines through 2006 (Linderman and Bue 2006). 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

Authors: Steve J. Miller and Ken C. Harper are fishery biologists with the U.S. Fish and Wildlife Service. The authors can be contacted through the Kenai Fish and Wildlife Field Office, 43566 Kalifornsky Beach Road, Soldotna, Alaska 99669; or steve_miller@fws.gov and ken_harper@fws.gov.

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). Those stocks of concern designations were discontinued by the Board in 2007 at the Alaska Yukon Kuskokwim (AYK) Regional meeting based on chum and Chinook salmon runs above or at the historical level since 2002 (John Linderman, personal communication).

The Alaska Department of Fish and Game (Department), U.S. Fish and Wildlife Service (Service), and the Kuskokwim River Salmon Management Working Group (Working Group) work together to manage Kuskokwim River salmon resources. They are guided by the above state policies, federal mandates, and regulations for federal lands and rely upon a strategic array of enumeration studies carried out on tributaries of the Kuskokwim River. The Kwethluk River is an important tributary in the lower Kuskokwim River drainage and the Service and other agencies have funded several fisheries monitoring projects from 1991 to present. The objectives of this project remain consistent: (1) enumerate adult salmon; (2) describe the run timing for chum, Chinook, sockeye, pink, and coho salmon returns; (3) estimate the age, sex, and length composition of adult chum, Chinook, sockeye, and coho salmon populations; and (4) identify and count other fish species passing through the weir.

This weir project remains a high priority for the Office of Subsistence Management (OSM), the Department, and the Refuge, and continues to be supported. The Kenai Fish and Wildlife Field Office (KFWFO) and the Organized Village of Kwethluk (OVK) have cooperatively conducted weir project operations since 2000.

The Kwethluk River weir plays an important role as a platform to collect additional information and data for other research projects. These include: (1) genetic samples for other funded projects; (2) monitoring for sockeye, chum, and coho salmon tagged in Kuskokwim River mark-recapture projects for development of total in-river abundance estimates (Kerkvliet 2004; Pawluk 2006a and 2006b); (3) the Salmonid Rivers Observatory Network (SaRON), a 10 year project focused on pristine salmon rivers in the Bering Sea drainage measuring processes and changes to the shifting habitat mosaic of ecosystems (http://www.umt.edu/flbs/Research/SaRON.htm); and (4) the Arctic Yukon Kuskokwim Sustainable Salmon Initiative program (AYK-SSI) Kwethluk River chum salmon juvenile emigration study (http://www.aykssi.org/Research/index.html).

Study Area

The Kwethluk River is in the lower Kuskokwim River drainage (Figure 1). The region has a sub-arctic climate characterized by extremes in temperature. Temperatures range from summer highs near 15˚C to average winter lows near -12˚C (Alt 1977). Average yearly precipitation is approximately 50 cm, with the majority falling between June and October. The rivers in this area generally become ice-free in the slow current sections by early-May and freeze up in late-November. Break up on the Kwethluk River can occur from early-April to late May. The Kwethluk River originates in the Kilbuck Mountains, flows northwest approximately 222 km, and drains an area of about 3,367 km^2. The weir is located in the middle section of the river characterized by braiding and gravel substrates. Below the middle section, the lower 47 km consists of a deeper, muddy-bottomed channel that averages 53 m in width (Alt 1977). Turbid water conditions, the result of active stream cutting on tundra banks, are also characteristic of the lower section and are incompatible with weir operations.

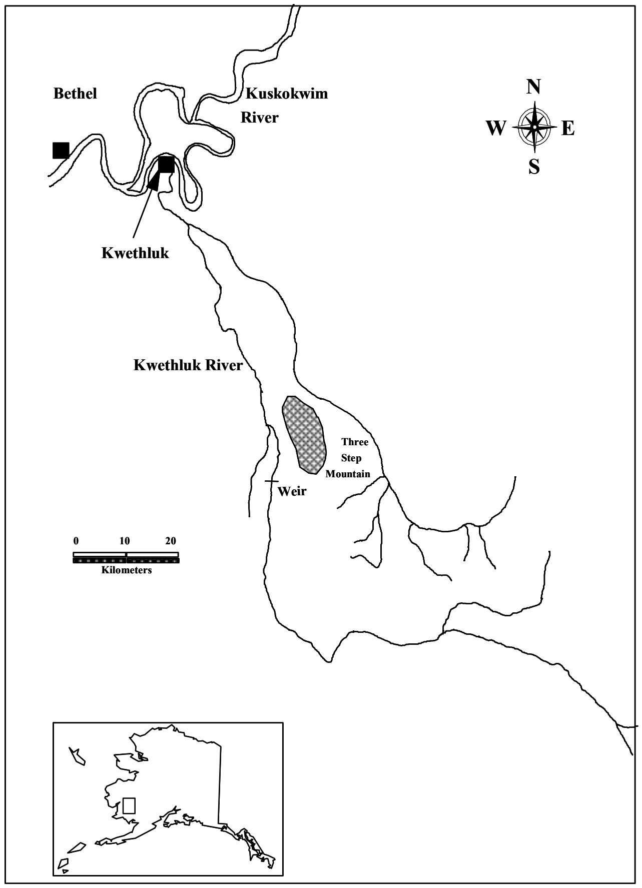

FIGURE 1.─Location of the Kwethluk River weir, 2007.

Methods

Weir Operations

A resistance board weir (Tobin 1994; Stewart 2002; Harper et al. 2007) spanning 56 m was installed in the Kwethluk River (N 60° 29'44.68", W 161° 05'54.79", NAD 83) approximately 88 rkm upstream from the Kuskokwim River and 43 air-km east of Kwethluk, Alaska (Figure 1). This location is approximately 2.4 rkm downstream from the 1992 weir site described by Harper (1998). The weir was relocated in 2000 due to channel morphology changes. A staff gauge was installed upstream of the weir to measure daily water levels and measurements were correlated to correspond with the average water depth across the river channel at the upstream edge of the weir. Water temperatures were collected daily from June 20 through September 9 using a Vemco® temperature data recorder at the SaRON project site (N 60° 25'02.30", W161 06' 46.20, NAD 83) approximately 8 rkm upriver of the weir.

One live trap and a counting passageway were installed to facilitate sampling and fish passage during varying river stage heights. Counts began at approximately 0600 hours each day and continued through 2300 hours as daylight permitted. Count periods varied with fish passage intensity and were recorded to the nearest 0.25 hours. All fish were enumerated to species as they migrated through the live trap or passage chute (Harper 1998).

The weir was inspected for holes and cleaned daily. An observer outfitted with a mask and snorkel checked weir integrity and substrate conditions. Debris was cleaned by raking debris from the upstream surface of the weir or walking across each panel until partially submerged, allowing the current to wash accumulated debris downstream.

Biological Data

A sample week (strata) began on Sunday and ended on Saturday. A weekly quota of 200 chum, 210 Chinook, and 200 sockeye salmon were sampled in as short a period (1-3 days) as possible to approximate a pulse or snapshot sample (Geiger et al. 1990). The sample objective for coho salmon was 210 for the season with samples from the early, middle, and late part of the run. All target species trapped were sampled to prevent bias.

Fish were sampled for length, sex, scales collected for ages, and tissue collected for genetics of targeted species. Fish were released upstream of the weir after sampling. Length was measured from mid-eye to the fork of the caudal fin and rounded to the nearest 5mm. Sex was determined by external characteristics, and or the presence of ovipositor or gametes. One scale was removed from the preferred area from each chum and sockeye salmon, and four scales from each Chinook and coho salmon for age determination (Koo 1962, Mosher 1968). Scale impressions were made on cellulose acetate cards, using a heated scale press, and examined with a microfiche reader (Molyneaux et al. 2008).

Characteristics of fish passing through the weir were estimated using standard stratified random sample estimators (Cochran 1977). Within a given stratum *m*, the proportion of species *i* passing the weir that are of sex *j* and age *k* (p_{ijkm}) 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 overall possible values of the corresponding variable, e.g., n_{j++m} denotes the total number of fish of species *i* sampled in stratum *m*. The variance was estimated as

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

where N_{i++m} denotes the total number of species *i* fish passing the weir in stratum *m*. The estimated number of fish 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* (μ_{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),

$$\hat{v}(\hat{\mu}_{ijk}) = \sum_m \left\{ \hat{v}(\hat{N}_{ijkm}) \left[\frac{\hat{\mu}_{ijkm}}{\sum_x \hat{N}_{ijkx}} - \sum_y \frac{\hat{N}_{ijky}\,\hat{\mu}_{ijky}}{\left(\sum_x \hat{N}_{ijkx} \right)^2} \right]^2 + \left(\frac{\hat{N}_{ijkm}}{\sum_x \hat{N}_{ijkx}} \right)^2 \hat{v}(\hat{\mu}_{ijkm}) \right\}$$

Genetics

Tissues and procedures for the various genetics projects were collected according to project specific protocols (Olsen et al. 2004, Crane et al. 2007, Liller et al. 2008). Collections were shipped to the Conservation Genetics Laboratory (CGL) in Anchorage for analysis and storage, or sub-sampled and shipped to other laboratories requesting tissue samples. See http://alaska.fws.gov/fisheries/genetics/reports.htm or http://ADFG/commercial.fisheries/Kusko.region/reports;.htm).

Post-spawn counts

Technicians counted post-spawn salmon and carcasses of dead salmon that washed up on the weir. Counts were to species and the salmon passed downstream. Carcasses were counted at the start of the first shift, each subsequent crew change, and the end of the last member's shift resulting in counts at least every four hours or as daylight permitted.

Results

Weir

Refuge pilots started monitoring water and ice conditions in the Kwethluk River in early March. A helicopter was used to transport crew members, equipment, and supplies to the site on April 15 to complete weir panel installation. Weir personnel returned to the weir site on June 16 to remove debris and mud from the rail and panels and set resistance boards. The trap was installed on June 20 and the weir was fully operational from June 24 to September 10. Water level and temperature data were collected daily (Appendix 1).

Biological Data

Chum Salmon — A total of 54,913 adult chum salmon passed through the weir. The first adult chum salmon migrated through the weir on June 25 and the last on September 5. Peak weekly passage for chum salmon (N=14,337) occurred July 8 to 14 (Figure 2). Median cumulative passage occurred on July 21 for adult chum salmon (Appendix 2) and August 3 for chum salmon carcasses, a difference of 18 days. The first chum salmon carcass passed downstream over the weir on July 1. Gillnet marks were observed on 2% of the 1,514 sampled chum salmon.

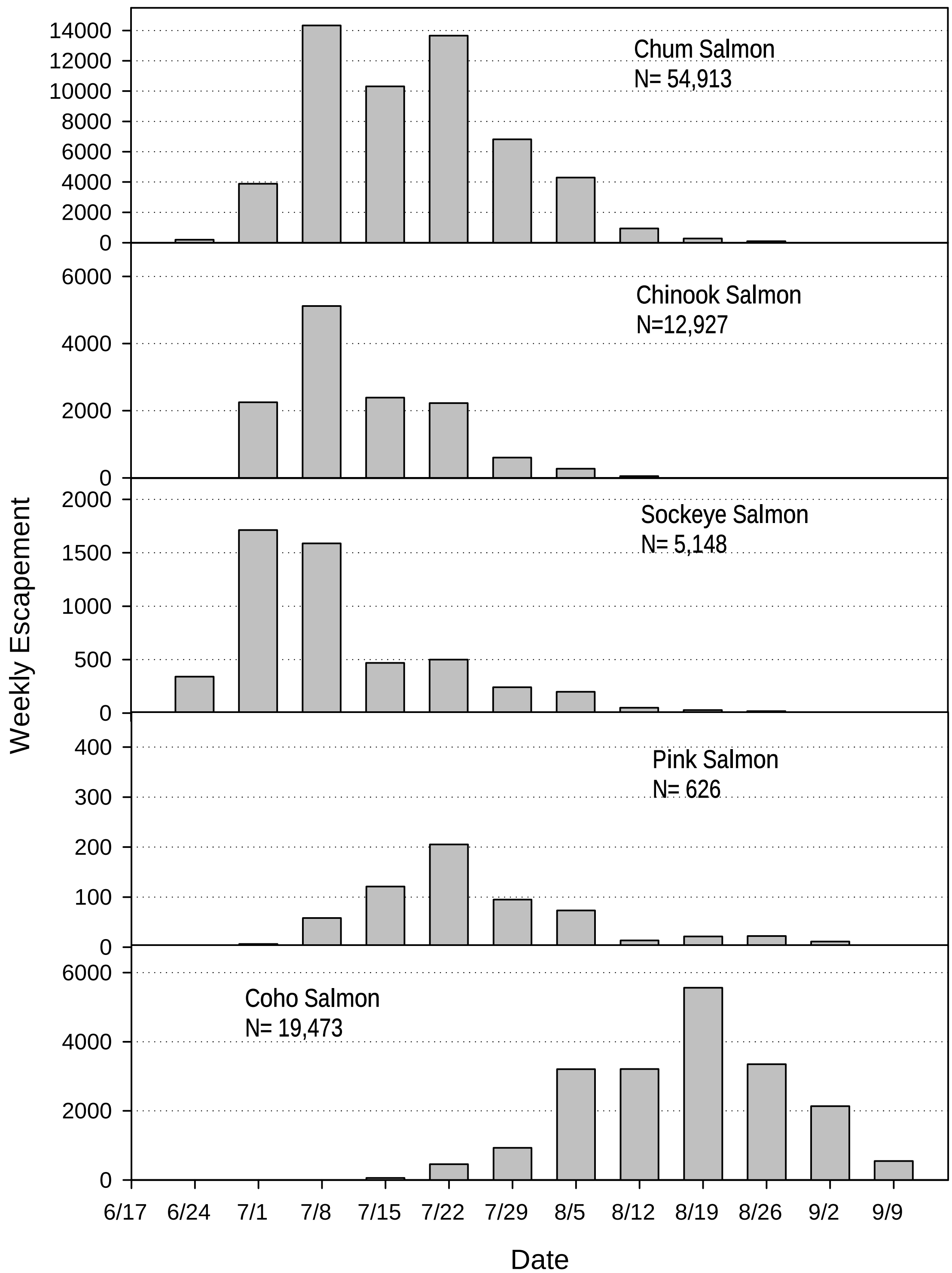

FIGURE 2.–Weekly passage of chum, Chinook, sockeye, pink, and coho salmon at the Kwethluk River weir, 2007.

Four age groups (0.2, 0.3, 0.4, and 0.5) were identified from chum salmon scale samples. The predominant age group was 0.3 for both male (69%) and female (73%) chum salmon (Appendix 3). Females comprised 45% of the total escapement (Figure 3, Appendix 3). Mean length of males was greater in all age groups than that of females (Appendix 4).

Chinook Salmon ─ A total of 12,927 Chinook salmon passed through the weir. The first adult Chinook salmon migrated through the weir on June 29 and the last on September 9. Peak weekly passage for Chinook salmon (N=5,114) occurred July 8 to 14 (Figure 2). Median cumulative passage occurred on July 13 for adult Chinook salmon (Appendix 2) and August 15 for Chinook salmon carcasses, a difference of 33 days. The first Chinook salmon carcass passed downstream over the weir on July 29. Gillnet marks were observed on 6% of the 965 sampled Chinook salmon.

Five age groups (1.1, 1.2, 1.3, 1.4, and 1.5) were identified from Chinook salmon scale samples. The predominant age group was 1.2 for males (58%) and 1.4 (59%) for females. Age groups 1.2 and 1.3 accounted for 89% of the male Chinook salmon escapement (Appendix 5). Females comprised 26% of the Chinook salmon escapement in the five strata sampled (Appendix 5). Age groups 1.3 and 1.4 accounted for 93% of the female Chinook salmon escapement. The percentage of females increased as the run progressed and made up 35% and 45% of the last 2 strata, respectively (Figure 3, Appendix 5). Mean length of females was greater than males in age groups 1.3, 1.4 and 1.5 and slightly less for age group 1.2 (Appendix 6).

Sockeye Salmon ─ A total of 5,148 adult sockeye salmon passed through the weir. The first adult sockeye salmon migrated through the weir on June 25 and the last on September 6. Peak weekly passage for sockeye salmon (N=1,704) occurred July 1 to 7 (Figure 2). Median cumulative passage occurred on July 9 for adult sockeye salmon (Appendix 2) and August 26 for sockeye salmon carcasses, a difference of 48 days. The first sockeye salmon carcass passed downstream over the weir July 20. Gillnet marks were observed on 5% of the 282 sampled sockeye salmon.

Eight age groups (1.1, 0.3, 1.2, 1.3, 2.2, 1.4, 2.3, and 2.4) were identified from scales taken from sockeye salmon. The predominant age group was 1.3 for both males and females and comprised 61% of the sockeye salmon sample. Females comprised 49% of the total sockeye salmon escapement (Appendix 7). The mean length of males was greater than females for all age groups (Appendix 8).

Pink Salmon ─ A total of 626 pink salmon passed through the weir. The first adult pink salmon migrated through the weir on July 7 and the last on September 9. Peak weekly passage of pink salmon (N=205) occurred July 22 to 28 (Figure 2). Median cumulative passage occurred on July 26 for adult pink salmon (Appendix 2) and August 8 for pink salmon carcasses, a difference of 13 days. A total of 325 pink salmon carcasses were passed downstream over the weir with the first on July 24 and the last on September 9. No gillnet marks were observed on pink salmon.

Coho Salmon ─ A total of 19,473 coho salmon passed through the weir. The first adult coho salmon migrated through the weir on July 15 and low numbers of adult coho salmon continued to migrate past the weir at take out on September 10. Peak weekly passage of coho salmon (N=5,563) occurred August 19 to 25 (Figure 2). Median cumulative passage occurred on August 21 for adult coho salmon (Appendix 2). The first adult coho salmon carcass to pass downstream over the weir was recorded on August 10. Gillnet marks were observed on 1% of the 957 sampled coho salmon.

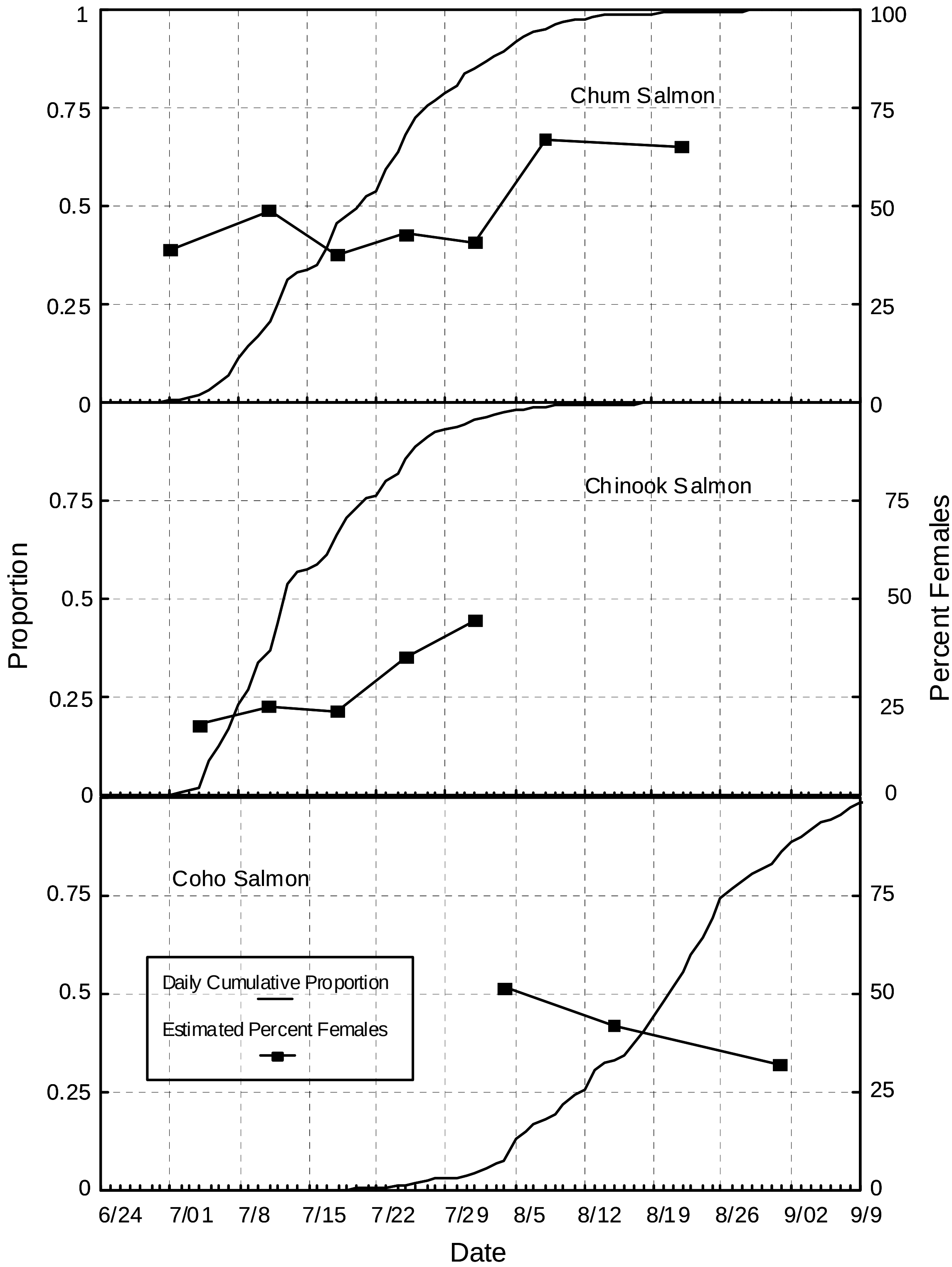

FIGURE 3.─Cumulative proportion and percent females for chum, Chinook, and coho salmon returning to the Kwethluk River during 2007. Percentage of females in the return was estimated by weekly strata for chum and Chinook salmon and during the early, middle and late portion of the return for coho salmon.

Three age groups (1.1, 2.1, and 3.1) were identified from scales of coho salmon. Age 2.1 was the predominant group for both males (84%) and females (94%). Females comprised 38% of the total escapement and were more prevalent in the early part of the coho salmon migration (Figure 3, Appendix 9). Mean lengths for ages 1.1 and 2.1 were slightly larger for males than females and essentially the same at age 3.1 (Appendix 10).

Genetics collections

Genetic tissue samples were collected from live migrating chum (N=200), Chinook (N=197), sockeye (N=171), pink (N=5), and coho (N=57) salmon. Genetic collections were sent to the CGL in Anchorage; sub-sampled if tissue was needed by the CGL, and collections forwarded to ADF&G Genetics Conservation Laboratory in Anchorage in September 2007.

Resident Species

In addition to the salmon, 20 Dolly Varden *Salvelinus malma*, 88 whitefish *Coregoninae* spp., 12 Arctic grayling *Thymallus arcticus*, 66 rainbow trout *O. mykiss* and one northern pike *Esox lucius Linnaeus* were counted through the weir. Nine rainbow trout mortalities and one Dolly Varden mortality were counted on the weir between August 10 and August 26.

Mark-Recapture Tag Recovery

No tagged fish of any species were noted migrating through the weir between June 24 and September 10, 2007.

Discussion

Weir Operations

Aerial surveys of the Kwethluk River were flown from late March through April to determine when the weir site was clear of ice and water levels low enough for installation of the weir. Weir installation during April avoids the annual high water event, which normally begins in May and often continues until August. High water events are controlled by air temperature, snow pack, and rainfall. Weir panels were installed in late April and the weir was operational from June 24 to September 10, 2007.

Picket spacing on the Kwethluk River weir is such that smaller pink salmon and resident species are able to pass uncounted between pickets while other salmon species are effectively monitored. Thus, counts of pink salmon and resident species are not representative of actual passage.

The Hobo® temperature recorder located at the weir was damaged sometime during the 2007 season and that data was unrecoverable. However, the SaRON project had a Vemco® temperature recorder in the Kwethluk River mainstem approximately 8 rkm above the weir site and that data was used in this report.

Biological Data

Chum Salmon ─ Chum salmon weir counts (N=54,913) were the highest on record and well above the 6-year average (years with complete counts) (Appendix 11). The median cumulative passage for chum salmon was July 21 which was about 3 to 6 days later than observed in prior years (Appendix 12). The proportion of female chum salmon (45%) was higher than 2003, 2004, and 2006, reversing a downward trend seen in past years (Appendix 12).

Chinook Salmon ─ The Chinook salmon weir count (N=12,927) was a decrease from the record escapement of 2004 and below the 6-year average (years with complete counts) (Appendix 11). The median cumulative passage for Chinook salmon was July 13, which was very similar to median passage dates, observed during 2000, 2003, and 2006 (Appendix 12). Female Chinook salmon comprised only (26%) of the run, which was much lower than 2006 but still higher than percentages observed from 1992 through 2004 (Appendix 12).

Sockeye Salmon ─ The Kwethluk River is not known for a large run of sockeye salmon. The observed count (N=5,148) of sockeye salmon in 2007 was the second highest recorded to date and well above a 6-year average (years with complete counts) (Appendix 11). The median cumulative passage date of July 9 was similar to that observed in 2002 and 2006 but 8 days later than 2000 and 2004 (Appendix 12). High numbers of sockeye salmon were also observed at other enumeration projects on the Kuskokwim River in 2007.

Pink Salmon ─ The observed passage of pink salmon (N=626) is a 60% decrease over 2003, which was the largest count for odd years since the weir with wider picket spacing came into use in 2000 (Harper 1998) (Appendix 11). Pink salmon counts were below a 5-year average (only even years used) (Appendix 11) and the median cumulative passage for pink salmon occurred five days earlier than in 2003 (Appendix 12). Age, sex, and length data were not collected for pink salmon.

Harper (1998) assumed that the wider spacing of the pickets would allow most pink salmon to pass upstream uncounted and expected that the ratio of carcasses washed up on the weir to total count to increase because 'mortalities' would have approximately the same odds of washing on to the weir while the migrating pink salmon would have a reduced chance of being counted. That ratio shift was not observed until 2006 (Miller et al. 2007). In 2007, the total number of pink salmon carcasses (N=325) counted back across the weir was >50% of the pink salmon escapement (N=626) which indicates that the wider picket spacing accomplished its intent.

Coho Salmon ─ The coho salmon count (N=19,473) was less than previous years. The 2007 coho salmon escapement is below the 7-year average (years with complete counts) and substantially below escapements observed in 1992, 2003 and 2004 (Appendix 11). The medium cumulative passage date, August 21, was similar to 2000 and 2006, but earlier than other years for coho salmon (Appendix 12). Female coho salmon comprised only (38%) of the run and was the second lowest on record at the Kwethluk River weir (Appendix 12).

Recommendations

The Kwethluk River weir continues to be an important project to monitor Kuskokwim River salmon stocks that originate on the Refuge and for providing information to the Department and Federal In-Season Subsistence Fishery Manager of the Kuskokwim River fisheries. We recommend annual operation of the weir to gather a long-term data set and operations into September to monitor coho salmon escapements. Early installation is essential to insure a successful weir installation, though more costly due to ice and debris damage to panels and increased cost for personnel and helicopter use.

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The U.S. Fish and Wildlife Service, Office of Subsistence Management provided funds for this project through the Fisheries Resource Monitoring Program, Project OSM 07-306. As a partner, OVK hired local residents to staff the weir, provided administrative support, purchased supplies, and performed equipment maintenance.

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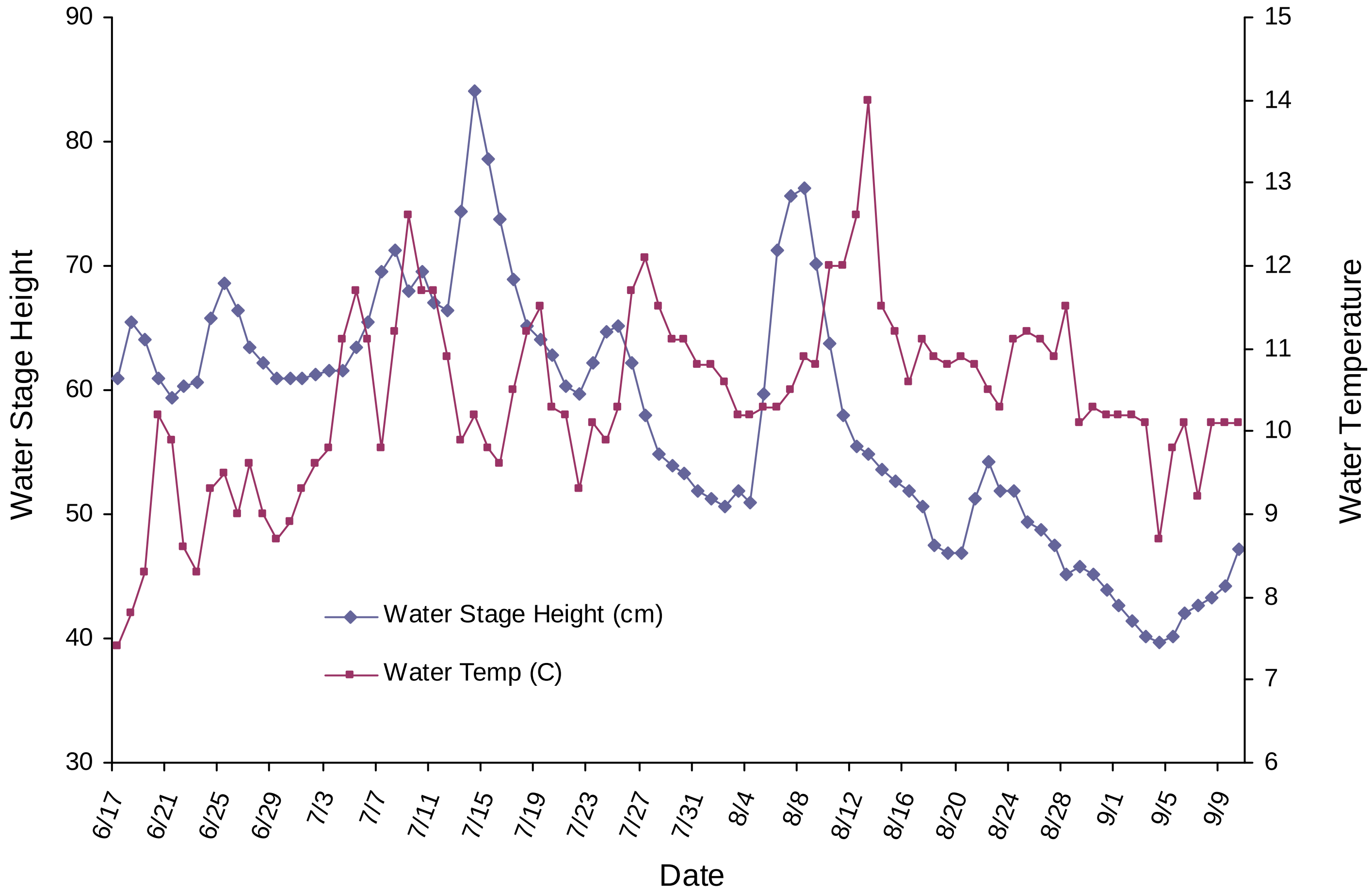

APPENDIX 1.—**Water stage heights at the Kwethluk River weir and water temperatures taken 8 rkm upriver of the weir, Alaska, 2007.**

APPENDIX 2.—Daily counts, cumulative counts, and cumulative proportions of chum, Chinook, sockeye, pink, and coho salmon escapement through the Kwethluk River weir, Alaska, 2007. Boxed areas represent the second and third quartile and median passage dates.

Date	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
6/24	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000	0	0	0.000
6/25	14	14	0.000	0	0	0.000	10	10	0.002	0	0	0.000	0	0	0.000
6/26	44	58	0.001	0	0	0.000	60	70	0.014	0	0	0.000	0	0	0.000
6/27	6	64	0.001	0	0	0.000	18	88	0.017	0	0	0.000	0	0	0.000
6/28	4	68	0.001	0	0	0.000	30	118	0.023	0	0	0.000	0	0	0.000
6/29	89	157	0.003	2	2	0.000	130	248	0.048	0	0	0.000	0	0	0.000
6/30	46	203	0.004	6	8	0.001	93	341	0.066	0	0	0.000	0	0	0.000
7/1	218	421	0.008	47	55	0.004	142	483	0.094	0	0	0.000	0	0	0.000
7/2	144	565	0.010	43	98	0.008	91	574	0.111	0	0	0.000	0	0	0.000
7/3	200	765	0.014	72	170	0.013	119	693	0.135	0	0	0.000	0	0	0.000
7/4	395	1160	0.021	126	296	0.023	205	898	0.174	0	0	0.000	0	0	0.000
7/5	859	2019	0.037	856	1152	0.089	516	1414	0.275	0	0	0.000	0	0	0.000
7/6	806	2825	0.051	500	1652	0.128	319	1733	0.337	0	0	0.000	0	0	0.000
7/7	1269	4094	0.075	603	2255	0.174	312	2045	0.397	6	6	0.010	0	0	0.000
7/8	2316	6410	0.117	804	3059	0.237	417	2462	0.478	5	11	0.018	0	0	0.000
7/9	1535	7945	0.145	434	3493	0.270	227	2689	0.522	8	19	0.030	0	0	0.000
7/10	1550	9495	0.173	934	4427	0.342	344	3033	0.589	8	27	0.043	0	0	0.000
7/11	1779	11274	0.205	371	4798	0.371	232	3265	0.634	11	38	0.061	0	0	0.000
7/12	2546	13820	0.252	897	5695	0.441	230	3495	0.679	16	54	0.086	0	0	0.000
7/13	3337	17157	0.312	1283	6978	0.540	100	3595	0.698	6	60	0.096	0	0	0.000
7/14	1274	18431	0.336	394	7372	0.570	39	3634	0.706	4	64	0.102	0	0	0.000
7/15	368	18799	0.342	139	7511	0.581	13	3647	0.708	5	69	0.110	5	5	0.000
7/16	603	19402	0.353	101	7612	0.589	37	3684	0.716	8	77	0.123	0	5	0.000
7/17	2481	21883	0.399	340	7952	0.615	110	3794	0.737	12	89	0.142	2	7	0.000
7/18	3304	25187	0.459	595	8547	0.661	122	3916	0.761	20	109	0.174	4	11	0.001
7/19	834	26021	0.474	572	9119	0.705	87	4003	0.778	23	132	0.211	0	11	0.001
7/20	1147	27168	0.495	379	9498	0.735	64	4067	0.790	25	157	0.251	28	39	0.002

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	Chum Salmon			Chinook Salmon			Sockeye Salmon			Pink Salmon			Coho Salmon		
Date	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
7/21	1581	28749	0.524	265	9763	0.755	36	4103	0.797	28	185	0.296	21	60	0.003
7/22	900	29649	0.540	146	9909	0.767	34	4137	0.804	14	199	0.318	9	69	0.004
7/23	2972	32621	0.594	467	10376	0.803	88	4225	0.821	33	232	0.371	46	115	0.006
7/24	2346	34967	0.637	235	10611	0.821	34	4259	0.827	32	264	0.422	34	149	0.008
7/25	2430	37397	0.681	513	11124	0.861	110	4369	0.849	31	295	0.471	93	242	0.012
7/26	2400	39797	0.725	354	11478	0.888	110	4479	0.870	46	341	0.545	129	371	0.019
7/27	1800	41597	0.758	364	11842	0.916	81	4560	0.886	34	375	0.599	105	476	0.024
7/28	822	42419	0.772	146	11988	0.927	43	4603	0.894	15	390	0.623	41	517	0.027
7/29	1095	43514	0.792	84	12072	0.934	37	4640	0.901	6	396	0.633	44	561	0.029
7/30	975	44489	0.810	79	12151	0.940	47	4687	0.910	27	423	0.676	49	610	0.031
7/31	1578	46067	0.839	99	12250	0.948	52	4739	0.921	17	440	0.703	121	731	0.038
8/1	738	46805	0.852	110	12360	0.956	20	4759	0.924	14	454	0.725	146	877	0.045
8/2	848	47653	0.868	100	12460	0.964	30	4789	0.930	10	464	0.741	155	1032	0.053
8/3	818	48471	0.883	89	12549	0.971	31	4820	0.936	15	479	0.765	244	1276	0.066
8/4	776	49247	0.897	42	12591	0.974	24	4844	0.941	6	485	0.775	171	1447	0.074
8/5	1383	50630	0.922	97	12688	0.982	61	4905	0.953	24	509	0.813	1048	2495	0.128
8/6	737	51367	0.935	51	12739	0.985	36	4941	0.960	10	519	0.829	453	2948	0.151
8/7	464	51831	0.944	50	12789	0.989	16	4957	0.963	2	521	0.832	253	3201	0.164
8/8	518	52349	0.953	39	12828	0.992	20	4977	0.967	13	534	0.853	326	3527	0.181
8/9	492	52841	0.962	21	12849	0.994	25	5002	0.972	8	542	0.866	274	3801	0.195
8/10	498	53339	0.971	11	12860	0.995	27	5029	0.977	8	550	0.879	488	4289	0.220
8/11	207	53546	0.975	5	12865	0.995	15	5044	0.980	8	558	0.891	368	4657	0.239
8/12	172	53718	0.978	6	12871	0.996	12	5056	0.982	1	559	0.893	331	4988	0.256
8/13	281	53999	0.983	9	12880	0.996	12	5068	0.984	4	563	0.899	974	5962	0.306
8/14	112	54111	0.985	5	12885	0.997	1	5069	0.985	1	564	0.901	348	6310	0.324
8/15	55	54166	0.986	6	12891	0.997	3	5072	0.985	2	566	0.904	153	6463	0.332
8/16	89	54255	0.988	7	12898	0.998	10	5082	0.987	1	567	0.906	216	6679	0.343
8/17	124	54379	0.990	7	12905	0.998	9	5091	0.989	3	570	0.911	597	7276	0.374

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Date	Chum Salmon Daily Count	Chum Salmon Cumulative Count	Chum Salmon Cumulative Proportion	Chinook Salmon Daily Count	Chinook Salmon Cumulative Count	Chinook Salmon Cumulative Proportion	Sockeye Salmon Daily Count	Sockeye Salmon Cumulative Count	Sockeye Salmon Cumulative Proportion	Pink Salmon Daily Count	Pink Salmon Cumulative Count	Pink Salmon Cumulative Proportion	Coho Salmon Daily Count	Coho Salmon Cumulative Count	Coho Salmon Cumulative Proportion
8/18	104	54483	0.992	8	12913	0.999	3	5094	0.990	1	571	0.912	594	7870	0.404
8/19	63	54546	0.993	3	12916	0.999	3	5097	0.990	2	573	0.915	715	8585	0.441
8/20	53	54599	0.994	3	12919	0.999	5	5102	0.991	0	573	0.915	708	9293	0.477
8/21	44	54643	0.995	2	12921	1.000	5	5107	0.992	1	574	0.917	730	10023	0.515
8/22	33	54676	0.996	1	12922	1.000	2	5109	0.992	2	576	0.920	742	10765	0.553
8/23	22	54698	0.996	1	12923	1.000	5	5114	0.993	5	581	0.928	847	11612	0.596
8/24	18	54716	0.996	1	12924	1.000	4	5118	0.994	8	589	0.941	902	12514	0.643
8/25	47	54763	0.997	2	12926	1.000	4	5122	0.995	3	592	0.946	919	13433	0.690
8/26	24	54787	0.998	0	12926	1.000	5	5127	0.996	3	595	0.950	1028	14461	0.743
8/27	17	54804	0.998	1	12927	1.000	2	5129	0.996	6	601	0.960	448	14909	0.766
8/28	13	54817	0.998	0	12927	1.000	2	5131	0.997	3	604	0.965	397	15306	0.786
8/29	18	54835	0.999	0	12927	1.000	5	5136	0.998	3	607	0.970	366	15672	0.805
8/30	11	54846	0.999	0	12927	1.000	3	5139	0.998	2	609	0.973	243	15915	0.817
8/31	2	54848	0.999	0	12927	1.000	1	5140	0.998	3	612	0.978	276	16191	0.831
9/1	16	54864	0.999	0	12927	1.000	0	5140	0.998	2	614	0.981	595	16786	0.862
9/2	3	54867	0.999	0	12927	1.000	1	5141	0.999	3	617	0.986	507	17293	0.888
9/3	9	54876	0.999	0	12927	1.000	1	5142	0.999	3	620	0.990	141	17434	0.895
9/4	8	54884	0.999	0	12927	1.000	3	5145	0.999	3	623	0.995	394	17828	0.916
9/5	14	54898	1.000	0	12927	1.000	0	5145	0.999	1	624	0.997	400	18228	0.936
9/6	6	54904	1.000	0	12927	1.000	1	5146	1.000	0	624	0.997	111	18339	0.942
9/7	4	54908	1.000	0	12927	1.000	0	5146	1.000	1	625	0.998	256	18595	0.955
9/8	0	54908	1.000	0	12927	1.000	0	5146	1.000	0	625	0.998	328	18923	0.972
9/9	4	54912	1.000	0	12927	1.000	2	5148	1.000	1	626	1.000	280	19203	0.986
9/10	1	54913	1.000	0	12927	1.000	0	5148	1.000	0	626	1.000	270	19473	1.000

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

		Brood Year and Age Group				
		2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	Total
Strata 1 - 2	06/24 - 07/07					
Sampling Dates:	07/02 - 07/07					
Male:	Number in Sample:	0	43	51	14	108
	Estimated % of Escapement:	0.0	24.2	28.7	7.9	61
	Estimated Escapement:	0	989	1173	322	2,484
	Standard Error:	0.0	128.8	136.1	81.0	
Female:	Number in Sample:	1	36	31	2	70
	Estimated % of Escapement:	0.6	20.2	17.4	1.1	39
	Estimated Escapement:	23	828	713	46	1,610
	Standard Error:	22.5	120.9	114.1	31.7	
Total:	Number in Sample:	1	79	82	16	178
	Estimated % of Escapement:	0.6	44.4	46.1	9.0	100
	Estimated Escapement:	23	1817	1886	368	4,094
	Standard Error:	22.5	149.5	150.0	86.1	
Stratum 3:	07/08 - 7/14					
Sampling Dates:	07/08					
Male:	Number in Sample:	0	63	27	6	96
	Estimated % of Escapement:	0.0	33.5	14.4	3.2	51
	Estimated Escapement:	0	4804	2059	458	7,321
	Standard Error:	0.0	491.6	365.3	183.1	
Female:	Number in Sample:	0	59	31	2	92
	Estimated % of Escapement:	0.0	31.4	16.5	1.1	49
	Estimated Escapement:	0	4499	2364	153	7,016
	Standard Error:	0.0	483.3	386.5	106.9	
Total:	Number in Sample:	0	122	58	8	188
	Estimated % of Escapement:	0.0	64.9	30.9	4.3	100
	Estimated Escapement:	0	9304	4423	610	14,337
	Standard Error:	0.0	497.1	481.1	210.2	

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		Brood Year and Age Group				
		2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	Total
Stratum 4:	07/15 - 07/21					
Sampling Dates:	07/15 - 07/16					
Male:	Number in Sample:	1	83	33	4	120
	Estimated % of Escapement:	0.5	43.2	17.2	2.1	63
	Estimated Escapement:	53	4460	1773	215	6,449
	Standard Error:	52.1	366.4	279.0	105.6	
Female:	Number in Sample:	3	54	15	3	72
	Estimated % of Escapement:	1.5	28.1	7.8	1.6	38
	Estimated Escapement:	158	2902	806	161	3,869
	Standard Error:	90	333	198	92	
Total:	Number in Sample:	0	137	48	7	192
	Estimated % of Escapement:	0.0	71.4	25.0	3.6	100
	Estimated Escapement:	0	7362	2580	376	10,318
	Standard Error:	0.0	334.4	320.3	138.6	
Stratum 5:	07/22 - 07/28					
Sampling Dates:	07/22					
Male:	Number in Sample:	2	80	24	0	106
	Estimated % of Escapement:	1.1	43.0	12.9	0.0	57
	Estimated Escapement:	147	5880	1764	0	7,790
	Standard Error:	102.9	494.2	334.6	0.0	
Female:	Number in Sample:	4	62	11	3	80
	Estimated % of Escapement:	2.2	33.3	5.9	1.6	43
	Estimated Escapement:	294	4557	808	220	5,880
	Standard Error:	144.8	470.5	235.5	125.7	
Total:	Number in Sample:	6	142	35	3	186
	Estimated % of Escapement:	3.2	76.3	18.8	1.6	100
	Estimated Escapement:	441	10436	2572	220	13,670
	Standard Error:	176.4	424.2	390.1	125.7	

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		Brood Year and Age Group				
		2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	Total
Stratum 6:	07/29 - 08/04					
Sampling Dates:	07/29					
Male:	Number in Sample:	0	82	25	3	110
	Estimated % of Escapement:	0.0	44.1	13.4	1.6	59
	Estimated Escapement:	0	3010	918	110	4,038
	Standard Error:	0.0	245.8	168.9	62.4	
Female:	Number in Sample:	3	62	9	2	76
	Estimated % of Escapement:	1.6	33.3	4.8	1.1	41
	Estimated Escapement:	110	2276	330	73	2,790
	Standard Error:	62.4	233.4	106.2	51.1	
Total:	Number in Sample:	3	144	34	5	186
	Estimated % of Escapement:	1.6	77.4	18.3	2.7	100
	Estimated Escapement:	110	5286	1248	184	6,828
	Standard Error:	62.4	207.0	191.4	80.1	
Stratum 7:	08/05 - 08/11					
Sampling Dates:	08/06 - 08/07					
Male:	Number in Sample:	0	53	9	0	62
	Estimated % of Escapement:	0.0	28.2	4.8	0.0	33
	Estimated Escapement:	0	1212	206	0	1,418
	Standard Error:	0.0	138.3	65.6	0.0	
Female:	Number in Sample:	5	100	19	2	126
	Estimated % of Escapement:	2.7	53.2	10.1	1.1	67
	Estimated Escapement:	114	2287	434	46	2,881
	Standard Error:	49.5	153.4	92.7	31.5	
Total:	Number in Sample:	5	153	28	2	188
	Estimated % of Escapement:	2.7	81.4	14.9	1.1	100
	Estimated Escapement:	114	3499	640	46	4,299
	Standard Error:	49.5	119.7	109.5	31.5	

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		Brood Year and Age Group				
		2003	2002	2001	2000	
		0.2	0.3	0.4	0.5	Total
Strata 8 - 12:	08/12 - 09/02					
Sampling Dates:	08/12 - 09/02					
Male:	Number in Sample:	0	61	12	1	74
	Estimated % of Escapement:	0.0	28.5	5.6	0.5	35
	Estimated Escapement:	0	376	74	6	456
	Standard Error:	0.0	37.3	19.0	5.6	
Female:	Number in Sample:	1	126	12	1	140
	Estimated % of Escapement:	0.5	58.9	5.6	0.5	65
	Estimated Escapement:	6	776	74	6	862
	Standard Error:	6	41	19	6	
Total:	Number in Sample:	1	187	24	2	214
	Estimated % of Escapement:	0.5	87.4	11.2	0.9	100
	Estimated Escapement:	6	1152	148	12	1,318
	Standard Error:	5.6	27.4	26.1	8.0	
Strata 1 - 12:	06/24 - 09/10					
Sampling Dates:	07/02 - 09/02					
Male:	Number in Sample:	3	465	181	28	676
	% Males in Age Group:	0.7	69.2	26.6	3.7	100
	Estimated % of Escapement:	0.4	37.8	14.5	2.0	55
	Estimated Escapement:	200	20731	7967	1111	29,956
	Standard Error:	115.4	847.2	612.3	234.9	
	Estimated Design Effects:	1.653	1.374	1.360	1.253	1
Female:	Number in Sample:	17	499	128	15	656
	% Females in Age Group:	2.8	72.8	22.2	2.8	100
	Estimated % of Escapement:	1	33	10	1	45
	Estimated Escapement:	706	18125	5530	706	24,908
	Standard Error:	189.5	812.3	526.8	200.7	
	Estimated Design Effects:	1.279	1.343	1.377	1.428	1
Total:	Number in Sample:	16	964	309	43	1,332
	Estimated % of Escapement:	1.3	70.8	24.6	3.3	100
	Estimated Escapement:	695	38856	13497	1816	54,864
	Standard Error:	194.9	786.9	747.0	306.8	
	Estimated Design Effects:	1.368	1.348	1.354	1.324	

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

		Brood Year and Age Group			
		2004	2003	2002	2001
		0.2	0.3	0.4	0.5
Strata 1 - 2:	06/24 - 07/07				
Sampling Dates:	07/01 - 07/04				
Male:	Mean Length		593	613	620
	Std. Error		6	6	10
	Range		530 - 725	525 - 715	535 - 680
	Sample Size	0	43	51	14
Female:	Mean Length	540	555	569	595
	Std. Error		8	8	25
	Range	540	460 - 700	450 - 645	570 - 620
	Sample Size	1	36	31	2
Stratum 3:	07/08 - 07/14				
Sampling Dates:	07/08 - 07/09				
Male:	Mean Length		575	593	598
	Std. Error		4	6	18
	Range		510 - 630	520 - 670	535 - 650
	Sample Size	0	63	27	6
Female:	Mean Length		539	567	543
	Std. Error		3	5	13
	Range		485 - 600	520 - 630	530 - 555
	Sample Size	0	59	31	2
Stratum 4:	07/15 - 07/21				
Sampling Dates:	07/15				
Male:	Mean Length	605	571	581	593
	Std. Error		4	7	13
	Range	605	450 - 640	500 - 655	560 - 620
	Sample Size	1	83	33	4
Female:	Mean Length	528	528	540	555
	Std. Error	11	5	10	9
	Range	515 - 550	410 - 600	470 - 605	540 - 570
	Sample Size	3	54	15	3

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		Brood Year and Age Group			
		2004	2003	2002	2001
		0.2	0.3	0.4	0.5
Stratum 5:	07/22 - 07/28				
Sampling Dates:	07/22				
Male:	Mean Length	573	576	584	
	Std. Error	23	3	8	
	Range	550 - 595	515 - 695	500 - 660	
	Sample Size	2	80	24	0
Female:	Mean Length	533	536	552	573
	Std. Error	11	3	6	19
	Range	500 - 550	485 - 590	520 - 585	535 - 595
	Sample Size	4	62	11	3
Stratum 6:	07/29 - 08/04				
Sampling Dates:	07/29				
Male:	Mean Length		559	566	577
	Std. Error		3	6	3
	Range		495 - 660	505 - 620	570 - 580
	Sample Size	0	82	25	3
Female:	Mean Length	538	539	534	533
	Std. Error	18	3	9	8
	Range	505 - 565	500 - 660	490 - 575	525 - 540
	Sample Size	3	62	9	2
Stratum: 7	08/05 - 08/11				
Sampling Dates:	08/06 - 08/07				
Male:	Mean Length		570	575	
	Std. Error		5	8	
	Range		510 - 640	535 - 615	
	Sample Size	0	53	9	0
Female:	Mean Length	514	540	540	563
	Std. Error	8	2	7	13
	Range	495 - 535	485 - 595	495 - 610	550 - 575
	Sample Size	5	100	19	2

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		Brood Year and Age Group			
		2004	2003	2002	2001
		0.2	0.3	0.4	0.5
Strata: 8,9,10,11,12	08/12 - 09/10				
Sampling Dates:	08/12 - 09/02				
Male:	Mean Length		574	579	545
	Std. Error		7	13	
	Range		465 - 715	500 - 660	545
	Sample Size	0	61	12	1
Female:	Mean Length	505	531	540	535
	Std. Error		2	7	.
	Range	505	455 - 620	500 - 580	535
	Sample Size	1	126	12	1
Season Strata: 1 - 12	06/24 - 09/10				
Sampling Dates:	07/01 - 09/02				
Male:	Mean Length	581	572	587	601
	Std. Error	23	2	3	9
	Range	550 - 605	450 - 725	500 - 715	535 - 680
	Sample Size	3	465	181	28
Female:	Mean Length	529	537	557	559
	Std. Error	6	1	3	7
	Range	495 - 565	410 - 700	450 - 645	525 - 620
	Sample Size	17	499	128	15

APPENDIX 5.—Estimated age and sex composition of weekly Chinook salmon escapements through the Kwethluk 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
Strata 1 - 2:	06/24 - 07/07						
Sampling Dates:	07/2 - 07/7						
Male:	Number in Sample:	0	58	32	8	1	99
	Estimated % of Escapement:	0.0	47.9	26.4	6.6	0.8	81.8
	Estimated Escapement:	0	1,081	596	149	19	1,845
	Standard Error:	0.0	100.0	88.3	49.8	18.1	
Female:	Number in Sample:	0	1	16	5	0	22
	Estimated % of Escapement:	0.0	0.8	13.2	4.1	0.0	18.2
	Estimated Escapement:	0	19	298	93	0	410
	Standard Error:	0.0	18.1	67.8	39.9	0.0	
Total:	Number in Sample:	0	59	48	13	1	121
	Estimated % of Escapement:	0.0	48.8	39.7	10.7	0.8	100.0
	Estimated Escapement:	0	1,100	895	242	19	2,255
	Standard Error:	0.0	100.1	98.0	62.0	18.1	
Stratum 3:	07/08 - 07/14						
Sampling Dates:	07/8 - 07/10						
Male:	Number in Sample:	0	77	48	19	0	144
	Estimated % of Escapement:	0.0	41.2	25.7	10.2	0	77.0
	Estimated Escapement:	0	2,107	1,313	520	0	3,940
	Standard Error:	0.0	181.2	160.9	111.3	0	
Female:	Number in Sample:	0	0	10	30	3	43
	Estimated % of Escapement:	0.0	0.0	5.3	16.0	1.6	23.0
	Estimated Escapement:	0	0	274	821	82	1,177
	Standard Error:	0.0	0.0	82.9	135.2	46.3	
Total:	Number in Sample:	0	77	58	49	3	187
	Estimated % of Escapement:	0.0	41.2	31.0	26.2	2	100
	Estimated Escapement:	0	2,107	1,587	1,341	82	5,117
	Standard Error:	0.0	181.2	170.3	161.9	46.3	

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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 4:	07/15 - 07/21						
Sampling Dates:	07/15 - 07/19						
Male:	Number in Sample:	1	93	48	14	1	157
	Estimated % of Escapement:	0.5	46.5	24.0	7.0	1	78.5
	Estimated Escapement:	12	1,112	574	167	12	1,877
	Standard Error:	11.4	80.9	69.3	41.4	11	
Female:	Number in Sample:	0	0	14	26	3	43
	Estimated % of Escapement:	0.0	0.0	7.0	13.0	2	21.5
	Estimated Escapement:	0	0	167	311	36	514
	Standard Error:	0.0	0.0	41.4	54.6	20	
Total:	Number in Sample:	1	93	62	40	4	200
	Estimated % of Escapement:	0.5	46.5	31.0	20.0	2	100
	Estimated Escapement:	12	1,112	741	478	48	2,391
	Standard Error:	11.4	80.9	75.0	64.9	22.7	
Stratum 5:	07/22 - 07/28						
Sampling Dates:	07/22 - 07/26						
Male:	Number in Sample:	0	81	28	9	1	119
	Estimated % of Escapement:	0.0	44.0	15.2	4.9	1	64.7
	Estimated Escapement:	0	979	339	109	12	1,439
	Standard Error:	0.0	78.2	56.6	34.0	12	
Female:	Number in Sample:	0	3	20	39	3	65
	Estimated % of Escapement:	0.0	1.6	10.9	21.2	2	35.3
	Estimated Escapement:	0	36	242	472	36	786
	Standard Error:	0.0	20.0	49.0	64.4	20	
Total:	Number in Sample:	0	84	48	48	4	184
	Estimated % of Escapement:	0.0	45.7	26.1	26.1	2	100
	Estimated Escapement:	0	1,016	580	580	48	2,225
	Standard Error:	0.0	78.5	69.2	69.2	23.0	

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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
Strata 6 - 9:	07/29 - 08/25						
Sampling Dates:	07/29 - 08/20						
Male:	Number in Sample:	0	52	19	8	0	79
	Estimated % of Escapement:	0.0	36.4	13.3	5.6	0	55.2
	Estimated Escapement:	0	341	125	53	0	519
	Standard Error:	0.0	34.9	24.6	16.7	0	
Female:	Number in Sample:	0	2	22	38	2	64
	Estimated % of Escapement:	0.0	1.4	15.4	26.6	1	44.8
	Estimated Escapement:	0	13	144	250	13	420
	Standard Error:	0.0	8.5	26.2	32.0	9	
Total:	Number in Sample:	0	54	41	46	2	143
	Estimated % of Escapement:	0.0	37.8	28.7	32.2	1	100
	Estimated Escapement:	0	355	269	302	13	939
	Standard Error:	0.0	35.2	32.8	33.9	8.5	

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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
Strata 1 - 9:	06/24 - 08/25						
Sampling Dates:	07/02 - 08/20						
Male:	Number in Sample:	1	361	175	58	3	598
	% Males in Age Group:	0.1	58.4	30.6	10.4	0.4	100.0
	Estimated % of Escapement:	0.1	43.5	22.8	7.7	0.3	74.4
	Estimated Escapement:	12	5,621	2,947	998	43	9,620
	Standard Error:	11.4	238.2	205.6	134.2	24.4	
	Estimated Design Effects:	0.772	1.217	1.263	1.326	0.965	1.148
Female:	Number in Sample:	0	6	82	138	11	237
	% Females in Age Group:	0.0	2.1	34.0	58.8	5.1	100.0
	Estimated % of Escapement:	0.0	0.5	8.7	15.1	1.3	25.6
	Estimated Escapement:	0	68	1,125	1,946	167	3,307
	Standard Error:	0.0	28.3	127.6	167.3	54.8	
	Estimated Design Effects:	0.000	0.826	1.085	1.156	1.236	1.148
Total:	Number in Sample:	1	367	257	196	14	835
	Estimated % of Escapement:	0.1	44.0	31.5	22.8	1.6	100.0
	Estimated Escapement:	12	5,689	4,073	2,944	210	12,927
	Standard Error:	11.4	238.4	223.8	200.5	59.9	
	Estimated Design Effects:	0.772	1.215	1.223	1.205	1.184	

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

		Brood Year and Age Group				
		2004	2003	2002	2001	2000
		1.1	1.2	1.3	1.4	1.5
Strata 1 - 2:	06/24 - 07/07					
Sampling Dates:	07/02 - 07/07					
Male:	Mean Length		546	662	837	775
	Std. Error		6	7	68	
	Range		445 - 650	570 - 775	610 - 1110	775 - 775
	Sample Size	0	58	32	8	1
Female:	Mean Length		510	741	812	
	Std. Error			7	31	
	Range		510 - 510	700 - 795	750 - 910	
	Sample Size	0	1	16	5	0
Stratum 3:	07/08 - 07/14					
Sampling Dates:	07/08 - 07/10					
Male:	Mean Length		551	684	836	
	Std. Error		4	7	23	
	Range		460 - 635	570 - 800	640 - 980	
	Sample Size	0	77	48	19	0
Female:	Mean Length			751	828	832
	Std. Error			13	13	11
	Range			705 - 820	700 - 945	810 - 845
	Sample Size	0	0	10	30	3

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		Brood Year and Age Group				
		2004	2003	2002	2001	2000
		1.1	1.2	1.3	1.4	1.5
Stratum 4:	07/15 - 07/21					
Sampling Dates:	07/15 - 7/19					
Male:	Mean Length	450	546	664	791	725
	Std. Error		5	9	36	
	Range	450	445 - 650	530 - 775	635 - 1100	725
	Sample Size	1	93	48	14	1
Female:	Mean Length			755	833	855
	Std. Error			11	11	40
	Range			705 - 825	735 - 910	785 - 925
	Sample Size	0	0	14	26	3
Stratum 5:	07/22 - 07/28					
Sampling Dates:	7/22, 7/24 - 7/26					
Male:	Mean Length		543	686	789	700
	Std. Error		5	10	25	
	Range		460 - 660	565 - 795	665 - 920	700
	Sample Size	0	81	28	9	1
Female:	Mean Length		545	731	860	863
	Std. Error		48	14	9	32
	Range		450 - 595	610 - 825	720 - 990	805 - 915
	Sample Size	0	3	20	39	3
Strata 6 - 9:	07/29 - 08/25					
Sampling Dates:	07/29 - 08/20					
Male:	Mean Length		547	671	803	
	Std. Error		7	15	29	
	Range		430 - 635	550 - 810	695 - 915	
	Sample Size	0	52	19	8	0
Female:	Mean Length		530	768	853	778
	Std. Error		10	11	9	8
	Range		520 - 540	615 - 835	770 - 960	770 - 785
	Sample Size	0	2	22	38	2

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		Brood Year and Age Group				
		2004	2003	2002	2001	2000
		1.1	1.2	1.3	1.4	1.5
Strata 1 - 9:	06/24 - 08/25					
Sampling Dates:	07/02 - 08/20					
Male:	Mean Length	450	547	673	813	733
	Std. Error		2	4	16	
	Range	450	430 - 660	530 - 810	610 - 1110	700 - 775
	Sample Size	1	361	175	58	3
Female:	Mean Length		534	749	844	837
	Std. Error		29	5	5	14
	Range		450 - 595	610 - 835	700 - 990	770 - 925
	Sample Size	0	6	82	138	11

APPENDIX 7.—Estimated age and sex composition of weekly sockeye salmon escapements through the Kwethluk 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	0.3	1.2	1.3	2.2	1.4	2.3	2.4	Total
Strata 1 - 12	06/2 - 09/10									
Sampling Dates:	7/01 - 8/26									
Female:	Number in Sample:	1	1	30	73	0	2	1	0	108
	Estimated % of Escapement:	0.5	0.5	13.7	33.3	0.0	0.9	0.5	0.0	49.3
	Estimated Escapement:	24	24	705	1,716	0	47	24	0	2,539
	Standard Error:	23.0	23.0	117.3	160.8	0.0	32.5	23.0	0.0	
Male:	Number in Sample:	1	0	41	61	3	1	3	1	111
	Estimated % of Escapement:	0.5	0.0	18.7	27.9	1.4	0.5	1.4	0.5	50.7
	Estimated Escapement:	24	0	964	1,434	71	24	71	24	2,609
	Standard Error:	23.0	0.0	133.1	152.9	39.7	23.0	39.7	23.0	
Total:	Number in Sample:	2	1	71	134	3	3	4	1	219
	Estimated % of Escapement:	0.9	0.5	32.4	61.2	1.4	1.4	1.8	0.5	100.0
	Estimated Escapement:	47	24	1,669	3,150	71	71	94	24	5,148
	Standard Error:	32.5	23.0	159.7	166.3	39.7	39.7	45.7	23.0	

APPENDIX 8.—Estimated length (mm) at age composition of weekly sockeye salmon escapements through the Kwethluk River weir, Alaska, 2007.

		Brood Year and Age Group							
		2004	2003		2002		2001		2000
		1.1	0.3	1.2	1.3	2.2	1.4	2.3	2.4
Strata 1 - 12	06/24 - 09/10								
Sampling Dates:	07/01 - 08/26								
Male:	Mean Length	545		587	587	565	590	590	575
	Std. Error			8.0	4.4	28.9		5	
	Range	545 - 545		450 - 695	500 - 670	515 - 615	590 - 590	585 - 600	575 - 575
	Sample Size	1	0	41	61	3	1	3	1
Female:	Mean Length		540	531	534		555	495	
	Std. Error			5.7	3.5		30.0		
	Range		540 – 540	450 -595	465 - 615		525 - 585	495 - 495	
	Sample Size	0	1	30	73	0	2	1	0

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

		Brood Year and Age Group			
		2004	2003	2002	
		1.1	2.1	3.1	Total
Strata 6 - 7:	07/29 - 08/11				
Sampling Dates:	07/29 - 08/08				
Male:	Number in Sample:	11	70	2	83
	Estimated % of Escapement:	6.4	40.9	1.2	48.5
	Estimated Escapement:	300	1,906	54	2,260
	Standard Error:	86.0	172.4	37.7	
Female:	Number in Sample:	5	79	4	88
	Estimated % of Escapement:	2.9	46.2	2.3	51.5
	Estimated Escapement:	136	2,151	109	2,397
	Standard Error:	59.1	174.8	53.0	
Total:	Number in Sample:	16	149	6	171
	Estimated % of Escapement:	9.4	87.1	3.5	100.0
	Estimated Escapement:	436	4,058	163	4,657
	Standard Error:	102.1	117.4	64.5	
Stratum 8:	08/12 - 08/18				
Sampling Dates:	08/12 - 08/13				
Male:	Number in Sample:	10	67	1	78
	Estimated % of Escapement:	7.5	50.0	0.7	58.2
	Estimated Escapement:	240	1,607	24	1,870
	Standard Error:	71.7	136.4	23.5	
Female:	Number in Sample:	3	52	1	56
	Estimated % of Escapement:	2.2	38.8	0.7	41.8
	Estimated Escapement:	72	1,247	24	1,343
	Standard Error:	40.3	132.9	23.5	
Total:	Number in Sample:	13	119	2	134
	Estimated % of Escapement:	9.7	88.8	1.5	100.0
	Estimated Escapement:	312	2,853	48	3,213
	Standard Error:	80.7	86.0	33.1	

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		Brood Year and Age Group			
		2004	2003	2002	
		1.1	2.1	3.1	Total
Strata 9 - 12:	08/19 - 09/10				
Sampling Dates:	08/19, 08/20, 08/26, 09/02				
Male:	Number in Sample:	9	52	0	61
	Estimated % of Escapement:	10.1	58.4	0.0	68.5
	Estimated Escapement:	1,173	6,779	0	7,953
	Standard Error:	371.5	607.3	0.0	
Female:	Number in Sample:	1	27	0	28
	Estimated % of Escapement:	1.1	30.3	0.0	31.5
	Estimated Escapement:	130	3,520	0	3,650
	Standard Error:	129.9	566.4	0.0	
Total:	Number in Sample:	10	79	0	89
	Estimated % of Escapement:	11.2	88.8	0.0	100.0
	Estimated Escapement:	1,304	10,299	0	11,603
	Standard Error:	389.1	389.1	0.0	
Strata 1 - 12:	06/24 - 09/10				
Sampling Dates:	07/29 - 09/02				
Male:	Number in Sample:	30	189	3	222
	% Males in Age Group:	14.2	85.2	0.6	100.0
	Estimated % of Escapement:	8.8	52.9	0.4	62.1
	Estimated Escapement:	1,713	10,292	78	12,083
	Standard Error:	388.0	645.8	44.4	
	Estimated Design Effects:	1.965	1.755	0.529	1.675
Female:	Number in Sample:	9	158	5	172
	% Females in Age Group:	4.6	93.6	1.8	100.0
	Estimated % of Escapement:	1.7	35.5	0.7	37.9
	Estimated Escapement:	338	6,918	133	7,390
	Standard Error:	148.3	607.5	58.0	
	Estimated Design Effects:	1.354	1.690	0.533	1.675
Total:	Number in Sample:	39	347	8	394
	Estimated % of Escapement:	10.5	88.4	1.1	100.0
	Estimated Escapement:	2,051	17,210	211	19,473
	Standard Error:	410.3	415.4	72.5	
	Estimated Design Effects:	1.872	1.762	0.527	

APPENDIX 10.—Estimated length (mm) at age composition of weekly coho salmon escapements through the Kwethluk River weir, Alaska, 2007.

		Brood Year and Age Group		
		2004	2003	2002
		1.1	2.1	3.1
Strata 1 - 5:	06/24 - 07/28			
No Samples Collected				
Strata 6 - 7:	07/29 - 08/11			
Sampling Dates:	07/29 – 0808			
Male:	Mean Length	544	559	545
	Std. Error	15	4	15
	Range	440 - 590	490 - 630	530 - 560
	Sample Size	11	70	2
Female:	Mean Length	559	531	565
	Std. Error	14	6	
	Range	515 - 585	445 - 640	485 - 615
	Sample Size	5	79	4
Stratum 8:	08/12 - 08/18			
Sampling Dates:	08/12 - 08/13			
Male:	Mean Length	562	576	560
	Std. Error	5	4	
	Range	540 - 585	445 - 660	560
	Sample Size	10	67	1
Female:	Mean Length	535	547	570
	Std. Error	5	6	
	Range	530 - 545	420 - 655	570
	Sample Size	3	52	1
Strata 9 - 12:	08/19 - 09/10			
Sampling Dates:	08/19 - 08/20, 08/26, 09/02			
Male:	Mean Length	585	573	
	Std. Error	14	4	
	Range	520 - 630	490 - 625	
	Sample Size	9	52	0
Female:	Mean Length	535	556	
	Std. Error	.	6	
	Range	535 - 535	490 - 615	
	Sample Size	1	27	0

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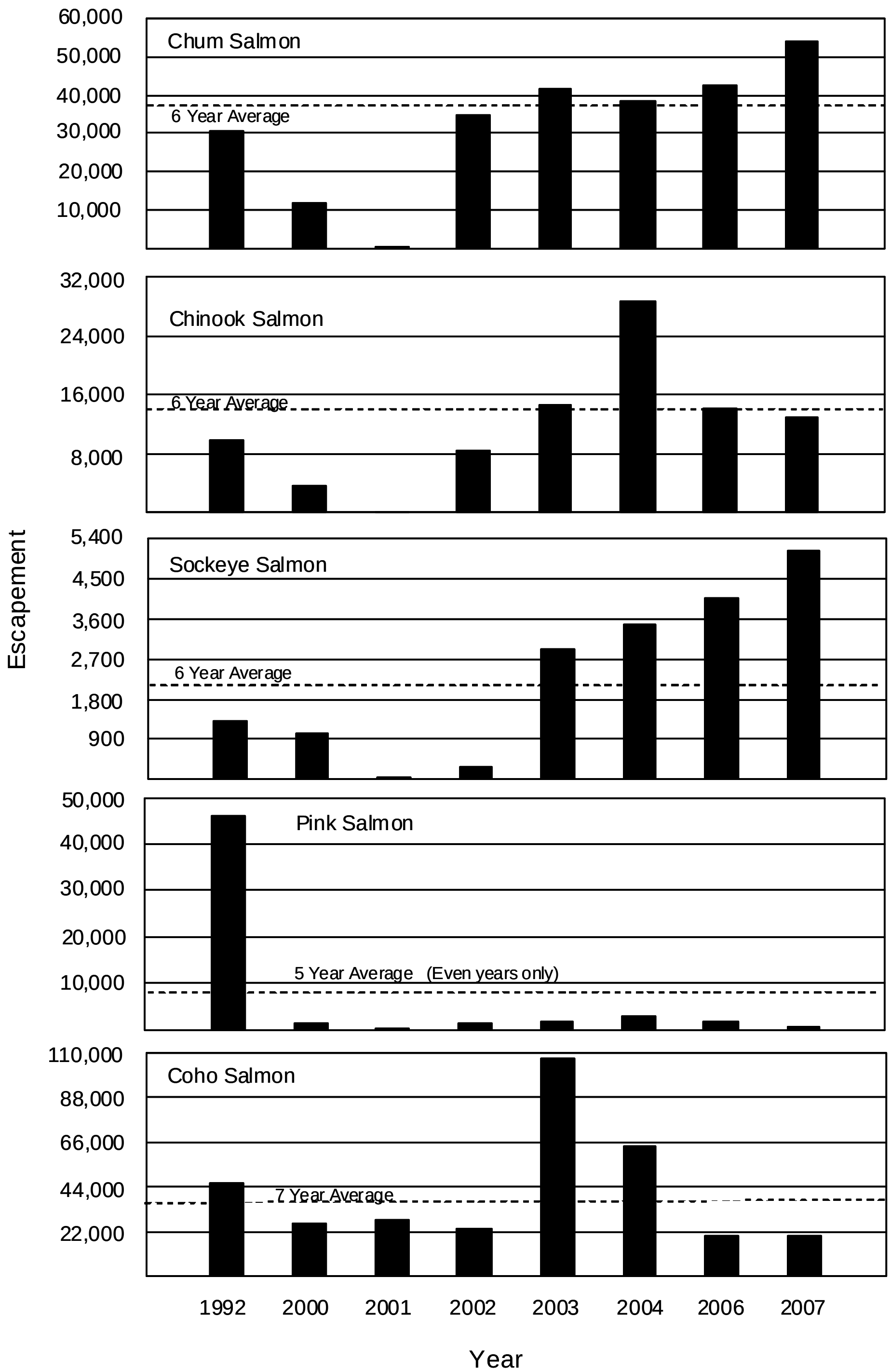
		Brood Year and Age Group		
		2004	2003	2002
		1.1	2.1	3.1
Strata 1 - 12:	06/24 - 09/10			
Sampling Dates:	07/17 - 09/02			
Male:	Mean Length	575	571	550
	Std. Error	10	3	15
	Range	440 - 630	445 - 660	530 - 560
	Sample Size	30	189	3
Female:	Mean Length	545	553	556
	Std. Error	9	3	30
	Range	515 - 585	420 - 655	485 - 615
	Sample Size	9	158	5



APPENDIX 11.–Estimates of salmon escapement through the Kwethluk River weir, Alaska, 1992, 2000-2004, 2006 and 2007. Enumeration for 2001 commenced on 8/12 and resulted in counts for coho salmon giving data for a 7-year average verses a 6-year average for Chinook, chum and sockeye salmon. Pink salmon averages are based on even years only. Averages do not include the current year.

APPENDIX 12.─Median cumulative passage dates and percent female for chum, Chinook, sockeye, pink and coho salmon at the Kwethluk river weir in 1992, 2000-2004, 2006 and 2007 (Harper 1998; Harper and Watry 20001; Roettiger at al. 2002, 2003, 2004, 2005; Miller et al. 2007).

	Chum		Chinook		Sockeye		Pink		Coho	
Year	Date	Percent Female	Date	Percent Female	Date	Percent Female	Date	Percent Female	Date	Percent Female
1992	7/18	54	7/9	25	7/18	60	8/13	-	8/26	43
2000	7/16	50	7/13	21	7/1	49	8/4	-	8/21	45
2001	-	-	-	-	-	-	-	-	8/25	51
2002	7/17	47	7/10	22	7/11	60	7/25	-	8/28	45
2003	7/22	44	7/11	19	7/7	55	8/1	-	8/29	51
2004	7/14	43	7/8	17	7/1	48	8/6	-	8/29	43
2006	7/15	41	7/12	40	7/10	43	7/22	-	8/19	37
2007	7/21	45	7/13	26	7/9	49	7/26	-	8/21	38