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ANVIK RIVER SALMON ESCAPEMENT STUDY, 1994

By

Gene J. Sandone

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AUTHOR

Gene J. Sandone is a Yukon River Research Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, 333 Raspberry Road, Anchorage, AK 99518.

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ABSTRACT

Since 1979 the Anvik River sonar project has estimated daily passage of summer chum salmon *Oncorhynchus keta* using side-scanning sonar counters. During the period 19 June through 23 July 1994, an estimated 1,124,689 summer chum passed the sonar site on the Anvik River. This summer chum salmon estimate is 2.25 times above the minimum escapement objective of 500,000 salmon. Overall, the 1994 summer chum salmon run was slightly early. Specifically, all quartile passage days were earlier than the long-term mean (1979-1993, excluding 1986) timing statistics. The first quartile passage day was 2 d earlier than the long-term average first quartile day; the median passage day was 1 d earlier; and third quartile passage day was 2 d earlier. Female chum salmon comprised an estimated 58.7% of the summer chum salmon passage. Age-4 fish comprised an estimated 35.0% of the passage; age-5 fish accounted for 63.8%. Proportion of age-5 salmon decreased over time. However, age-5 salmon dominated the first three sampling strata ranging from 76.7% in the first stratum to 57.2% in the third stratum. Age-5 salmon comprised an estimated 50.4% of the escapement in the final stratum. Proportion of female chum salmon increased over time. Female salmon dominated all sampling stratum ranging from 55.5% in the first sampling stratum to 70.4% in the final stratum. A total of 913 chinook salmon *O. tshawytscha* were enumerated on an aerial survey of the mainstem index area within Anvik River drainage. Although this survey was completed under poor survey conditions, the count is 1.8 times the minimal escapement goal of 500 chinook salmon for this index area. Age-5 salmon dominated the chinook salmon escapement, accounting for 63.3% of the carcass samples. Age-6 salmon accounted for 34.3%. Male chinook salmon dominated the escapement, accounting for 59.6% of the sample.

INTRODUCTION

Two distinct runs of chum salmon *Oncorhynchus keta*, summer and fall, spawn in the Yukon River drainage. The Anvik River, which empties into the Yukon River at river kilometer (rkm) 512 (Figure 1), is the largest producer of summer chum salmon in the Yukon River drainage. Buklis (1982a) estimated that the Anvik River alone accounts for 35% of the total production. Other known major spawning populations occur in other tributaries of the Yukon River, such as, the Andreafsky (rkm 167), Rodo (rkm 719), Nulato (rkm 777), Melozitna (rkm 938), and the Tozitna Rivers (rkm 1,096); in tributaries to the Koyukuk River (rkm 817), such as, the Gisasa (rkm 907) and Hogatza (rkm 1,255) Rivers; and in tributaries to the Tanana River (rkm 1,118), such as the Chena (rkm 1,480), and Salcha (rkm 1,553) Rivers (Figure 1). Summer chum salmon spawn in lesser numbers in other tributaries of the Yukon River. Chinook *O. tshawytscha* and pink *O. gorbuscha* salmon occur in the Anvik River coincidentally with summer chum salmon. Coho salmon *O. kisutch* spawn in the Anvik River drainage during the fall.

Harvest of Anvik River Salmon

Commercial and subsistence harvests of Anvik River summer chum salmon occur throughout the mainstem Yukon River from the coast of the delta to the mouth of the Anvik River, and beginning in 1994, in a special harvest area within the Anvik River. This section of river includes Districts 1, 2, 3 and the extreme lower portion of District 4 (Figure 1). Set and drift gillnets are the legal fishing gear in Districts 1, 2, and 3; set gillnets and fish wheels are used in District 4. Most of the effort and harvest on the Anvik River stock occurs in Districts 1 and 2 and in the extreme lower portion of District 4 below the confluence of the Anvik and Yukon Rivers. Fish taken commercially in the lower three districts are sold in the round. Summer chum salmon roe is the chief commercial product from the District 4 fishery. Whole chum salmon are not bought in District 4 because of poor flesh quality and distance from market. Subsistence fisheries in Districts 1, 2, and 3 take summer chum salmon primarily for human consumption. Subsistence harvest of summer chum salmon in District 4 is primarily for sled dog food. Commercial and subsistence summer chum salmon fisheries in the remainder of District 4 and in District 6 are supported by stocks other than the Anvik River stock. Very few summer chum salmon are harvested in District 5 because of the lack of spawning populations in that portion of the drainage.

In the lower portion of the Yukon River (Districts 1, 2, 3), run timing of chinook and summer chum salmon greatly overlap from river-ice breakup through June or early July. During this period, management of the lower Yukon River has traditionally been directed at chinook salmon. The District 4 commercial fishery has been directed primarily at chum salmon. In the Lower Yukon Area, large-mesh gillnets (stretch mesh greater than 6 in) were traditionally employed to harvest chinook salmon during June and early July. Although large-mesh nets are very efficient for chinook salmon in these districts during the chinook-directed periods, the associated harvest of summer chum salmon was small in relation to the size of the summer chum salmon run.

Therefore, prior to the 1985 season, the Alaska Board of Fisheries, in an attempt to allow more harvest of summer chum salmon in the lower river, directed that special small-mesh (stretch mesh maximum of 6 in) fishing periods be allowed during the chinook salmon season provided that (1) the summer chum salmon run was of sufficient size to support the additional exploitation, and (2) the incidental harvest of chinook salmon during these small-mesh fishing periods did not adversely affect conservation of that species.

Strong runs resulted in record commercial harvests of 1,620,269 summer chum salmon in 1988 and 1,456,928 in 1989 (Bergstrom et al. 1992). Distribution of the summer chum salmon catch among districts reflected stock distribution, market demand, and scheduled fishing time. Without harvest guidelines, increased market demand prompted allocation disputes between district fishermen. To address this situation the Alaska Board of Fisheries, in February 1990, established a river-wide guideline harvest range of 400,000 to 1,200,000 summer chum salmon (ADF&G 1990). This overall guideline was distributed by district and subdistrict based on the previous 15-year average harvests.

Because of relatively very large summer chum salmon escapements to the Anvik River, which on the average (1979-1993) exceeded the present minimum escapement goal of 500,000 salmon by approximately 225,000 salmon, the Alaska Board of Fisheries, in March 1994, adopted the Anvik River chum salmon fishery management plan, which established regulations allowing a commercial summer chum salmon fishery within the Anvik River (ADF&G 1994a).

Prior to the 1994 season, the run-strength outlook for Yukon River summer chum was for a below average run. This was based on evaluation of parent-year escapements in 1990, and an assumed poor return of age-5 fish from the 1989 brood year. A poor return of the age-5 component was anticipated in the 1994 run because of the very poor return of sibling, age-4 salmon in the 1993 run. It was also noted that if the return of age-4 salmon in the 1994 run was similar to the very poor return of age-4 salmon in the 1993 run, the 1994 summer chum salmon run could be critically low (ADF&G 1994b). Accordingly, no commercial harvest of summer chum salmon was expected. Additionally, if the 1994 run appeared critically low, more stringent conservation management actions would have been necessary to assure that escapement goals were met (ADF&G 1994b).

In early July 1994, the department projected that chum salmon escapement to the Anvik River would probably be twice the minimum escapement goal of 500,000. Because of this large surplus of Anvik River chum salmon, emergency regulations were quickly adopted to provide for a chum salmon-directed commercial fishery within the Anvik River in 1994. Because buyers were not prepared to buy whole salmon, the emergency regulations allowed the sale of chum salmon roe. Additionally, so the fishery would be conducted in an orderly manner, each CFEC permit holder was limited to a catch limit of 400 chum salmon or 400 pounds of roe during each commercial fishing period. Further, to protect the Anvik River chinook salmon spawning stock, all chinook salmon caught during commercial fishing periods were to be returned to the water alive.

During the 1994 summer season the lower 12 miles of the Anvik River were open to commercial fishing during six fishing periods. A total of 19,532 pounds of roe were sold from this fishery. Based on roe weight samples, an estimated 22,434 female summer chum salmon were harvested. Because most fishers used beach seines, most male chum salmon, as well as chinook salmon and other resident fish species, were released.

Stock Identification Studies

Two stock identification studies have been conducted on Yukon River chum salmon stocks. Initially, a small-scale stock identification investigation using scale pattern analysis was conducted by the Alaska Department of Fish and Game (ADF&G). Results of this pilot study indicated that separation of chum salmon stocks by scale pattern analysis was probably not feasible (Wilcock 1988). A more recent stock identification study (Wilmot et al. 1992) reported success in separating Yukon River chum salmon stocks using protein electrophoresis techniques. This study was initiated in 1987 by the United States Fish and Wildlife Service (USFWS) and continued through the 1991 season. Preliminary results indicated that among all represented chum salmon stocks of the Yukon River, two major groups were apparent, a summer-run group and a fall-run group. These investigators also reported that within the summer-run group, two major subdivisions were apparent, those of the lower river below rkm 800 and those of the mid river (rkm 800-1,150). Wilmot et al. (1992) reported that estimated stock compositions of samples collected from District 1 commercial and test net fisheries during 1987 to 1990 indicated that the lower river summer-run chum salmon stocks contributed 75-100% to the catch until mid-July.

During the 1987 and 1988 field season, chum salmon genetic stock identification (GSI) collections were obtained at the mainstem Anvik River sonar site. Interestingly, these two collections were significantly different genetically (Wilmot et al. 1992). Although the collection obtained in 1987 was genetically similar to the lower river summer-run group, the collection obtained in 1988 was reported to be a separate group within the summer-run group and genetically distinct from the lower and mid-river groups (Wilmot et al. 1992). These investigators speculated that because the Anvik River is a large, productive river system that probably supports numerous spawning stocks, the mainstem collections at the sonar site in 1987 and 1988 most likely included different combinations of genetically distinct stocks. This apparent under-representation of Anvik River sub-populations in the genetic baseline data set was identified as one of the limitations of the study (Wilmot et al. 1992). Recent GSI studies on chum salmon tributary populations within the Anvik River indicate that there are genetically distinct populations within the Anvik River chum salmon stock (Crane et al. 1994).

Escapement Assessment

Accurate salmon escapement assessment on Yukon River tributaries is important for regulating fishery harvests, setting escapement goals, evaluating the effectiveness of management programs, and providing information for use in projecting subsequent returns. However, because of the vast size of the Yukon River drainage, 853,000 km^2, low-level aerial surveys conducted from single-engine, fixed-wing aircraft have been used to provide indices of escapement for selected spawning areas. The counts obtained are only indices of abundance because the entire escapement is not present on the day of the survey and not all the fish present are seen and counted. Additionally, the quality of the survey count may vary because of weather and stream conditions, timing of the survey relative to spawning stage, number of other species of salmon present, and observer subjectivity and experience. Attempts to standardize the conditions under which these indices are conducted improves their usefulness in monitoring the relative abundance of spawning escapements.

Chinook salmon escapements to the major spawning areas in the Yukon River drainage have been estimated by aerial survey from fixed-wing aircraft on a consistent basis since the early 1960s. Chum salmon escapements have been estimated by this method since the early 1970s. Escapement goals based on aerial surveys have been established for both chinook and chum salmon in selected tributary streams for which there is a sufficient historical database (Schultz et al. 1993).

Comprehensive escapement assessment studies have been conducted on only a few selected spawning streams for each run of chum salmon in the Yukon River drainage. The Anvik River was chosen for summer chum salmon research studies in 1972 and the Andreafsky and Melozitna Rivers (Figure 1) in 1981. However, because of budget restrictions, the Melozitna River project was discontinued in 1984, and the Andreafsky River project was discontinued in 1989. During 1993, counting towers for chinook and summer chum assessment were operated by Sport Fish Division on the Chena and Salcha Rivers in the Tanana River drainage. During the 1994 season, in addition to the Anvik River sonar project and the Chena and Salcha River counting-tower projects, the USFWS operated counting weirs on the East Fork Andreafsky River and Gisasa River. Additionally, counting towers were operated on the mainstem Nulato River and Kaltag Creek (rkm 724). The Nulato River counting tower project was cooperatively funded by Bering Sea Fishermen's Association (BSFA), Tanana Chiefs Conference (TCC) and ADF&G. The Kaltag counting-tower project was funded by Alaska Cooperative Extension 4-H Program, and partially funded by BSFA.

Study Area

The Anvik River originates at an elevation of 400 m and flows in a southerly direction approximately 200 km to its mouth at rkm 512 of the Yukon River. It is a narrow runoff stream with a substrate mainly of gravel and cobble. However, bedrock is exposed in some of the upper reaches. The Yellow River (Figure 2), a major tributary of the Anvik, is located approximately 100 km upstream from the mouth of the Anvik River. Downstream of the confluence of the Yellow and Anvik Rivers, the Anvik River changes from a moderate gradient system to a low gradient system meandering through a much broader flood plain. Turbid waters from the Yellow River also greatly reduce the water clarity of the Anvik River below this confluence. Numerous oxbows, old channel cutoffs, and sloughs are found throughout the lower river.

Anvik River salmon escapement was partially enumerated from two counting tower sites from 1972 to 1979 above the confluence of the Anvik and Yellow Rivers (Figure 2). A site 9 km above the Yellow River on the mainstem Anvik River was used from 1972 to 1975 (Lebida 1973; Trasky 1974, 1976; Mauney 1977). From 1976 to 1979 a site on the mainstem Anvik River near the confluence of Robinhood Creek and the Anvik River was used (Figure 2; Mauney 1979, 1980; Mauney and Geiger 1977). Other than 1974, aerial surveys were flown each year in fixed-wing aircraft to estimate salmon abundance below the tower site. High and turbid water often affected the accuracy of visual salmon enumeration from counting towers, as well as by aerial survey.

The Electrodynamics Division of the Bendix Corporation[2] developed a side-scanning sonar counter during the 1970s capable of detecting and counting salmon migrating along the banks of streams. A pilot study using side-scanning sonar to estimate chum salmon escapement to the Anvik River was conducted in 1979. Results of this study indicated that sonar enumeration of chum salmon escapements to the Anvik River was superior to the counting tower method (Mauney and Buklis 1980). Therefore, in 1980, sonar enumeration replaced the tower counting method for estimating summer chum salmon escapement.

The Anvik River sonar site is located approximately 76 km upstream of the confluence of the Anvik and Yukon Rivers (Figure 2). Project results for escapement studies using sonar technology on the Anvik River from 1979 to 1992 have been reported by Mauney and Buklis (1980), Buklis (1981, 1982b, 1983, 1984a, 1984b, 1985, 1986, 1987), and Sandone (1989, 1990a, 1990b, 1993, 1994a, 1994b). This report presents results of the Anvik River summer chum salmon escapement project for the 1994 field season.

Objectives

Because the majority of the subsistence harvest and some of the commercial summer chum salmon harvest occur in the Yukon River drainage above the mouth of the Anvik River, it is important to accurately assess the strength of the upriver run so that escapement and harvest needs can be met. The information derived from this project, in conjunction with Yukon River sonar passage estimates and subsistence and commercial harvests, has been used to assess the strength of the Yukon River summer chum salmon run above the mouth of the Anvik River. The timely and accurate reporting of information from the Anvik River sonar project is a critical component of Yukon River summer chum salmon management. The primary purpose of this project is to monitor the escapement of summer chum salmon to the Anvik River. The two primary objectives of this project are to:

1. estimate the daily summer chum salmon escapement passing the Anvik River sonar site; and

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2. estimate the age and sex composition of the summer chum and chinook salmon spawning escapements.

METHODS

Sonar Deployment and Operation

A sonar counter has been installed and operated on each bank of the Anvik River near Theodore Creek (Figure 2) each year since 1979. The sonar counter operates by transmitting a sonic beam along an 18-m aluminum tube, or substrate. Echoes from salmon passing through the beam are reflected back to the transducer. The system electronics interpret the strength and number of the echoes, and tally salmon counts. Criteria for strength and frequency of the echoes are designed to count salmon and minimize non-salmon counts (i.e., debris or other fish species). Aerial survey data indicate that virtually all summer chum salmon spawning activity is located upstream of this site.

During the 1994 season, a 1981-model sonar counter was deployed and operated according to guidelines described by Bendix Corporation (1981) on each bank of the Anvik River to enumerate summer chum salmon passage. Sonar counters were operated without the prescribed artificial aluminum substrate tubes throughout the season. This practice of operation without an artificial substrate was first employed on the Anvik River in 1986 (Buklis 1986). The east and west bank sites used in previous years were probed to locate uniform river bottom gradients that would provide optimum surfaces for ensonification. Each sonar transducer was mounted on a rectangular aluminum frame. Two steel pipes were set into the river bottom on each side of the river, onto which the transducer frames were guided by side-mounted steel sleeves. Sandbags were placed on top of the transducer housing to ensure stability. Sonic beams emitted from each transducer were aimed perpendicular to shore; transducers were offset to prevent interference between units. To prevent fish passage inshore of the transducer, weirs constructed of T-stakes and rectangular mesh fencing were installed perpendicular to the shoreline and downstream of the transducer; they extended from the shore to approximately 1 m beyond the transducer. Counting towers of aluminum scaffolding material approximately 3 m in height were placed near the transducers on each bank for visual observation of salmon when water conditions permitted. Transducers were moved inshore or offshore, as required by fluctuating water levels. Consequently, depth at the transducer varied throughout the season. Transducers were aimed and counting range lengths were adjusted so that echoes resulting from the stream bottom or surface interface did not register as counts by the sonar electronics.

The 1981-model counters used on the Anvik River sonar project divided the counting range, or ensonified zone, into 16 sectors of equal length. Sector length was dependent on the length of the counting range. Sectors were consecutively numbered from the west (right) to east (left) bank. Therefore, sectors 1-16 were associated with the west bank counter, and sectors 17-32 were associated with the east bank counter. Sector number 1 and 32 corresponded to the nearest sectors to each bank.

The east bank transducer was located along a cutbank approximately 60 m above the field camp site. Initial placement of the east bank transducer was approximately 1.0 m offshore and at a depth of 1 m. The west bank transducer was located along a gradually sloping gravel bar, approximately 3 m downstream of the east bank transducer. Initial placement of the west bank transducer was approximately 9.0 m offshore and was also in water about 1 m deep.

Sonar Calibration and Sampling

Each sonar counter was usually calibrated four times daily by observing fish passage using an oscilloscope. Salmon passing through the sonar beam produce a distinctive oscilloscope trace or spike. During each calibration period counts of salmon enumerated by the observer using the oscilloscope were compared to counts recorded by the sonar electronics. The fish velocity control setting on the sonar counter was adjusted immediately after a calibration if the oscilloscope:sonar counts ratio varied from 1.0 by 15% or more. The existing fish velocity setting was multiplied by this ratio to obtain the correct new setting. If adjustments were made to the sonar unit an additional calibration was made to ensure that the oscilloscope:sonar count ratio was within accepted limits, ±15%, and to initialize the counting period. Each calibration lasted for at least 15 min or until 100 salmon were counted by the observer, whichever was less. Attempts were also made to visually enumerate fish passage from 3 m counting towers during sonar calibration times as a further check on sonar accuracy and to train operators in oscilloscope monitoring. Observers wore polaroid sunglasses to reduce water surface glare. Attempts to visually enumerate salmon during calibration times were discontinued from the west bank when it became apparent that the presence of the observer on the tower interfered with the normal passage of salmon past the sonar site. Salmon passed farther offshore when the observer was on the tower.

Four daily calibration times were deemed adequate to monitor the diel timing pattern of the salmon migration. Calibrations were normally conducted during 0600, 1200, 1800, and 2400 hours. However, during the initial and last days of the project when fish passage was low, calibrations were conducted during 0800, 1300, 1800, and 2400 hours. Occasionally, calibration times deviated from prescribed times because of more important priorities. Counting periods were defined by each calibration event. An adjustment factor, specific to each counting period and to each bank was calculated using the following formula:

$$A_{b,n} = \frac{(OC_{b,ts} + OC_{b,te})}{(SC_{b,ts} + SC_{b,te})}, \qquad (1)$$

where A = periodic adjustment factor,
b = west or east bank,
n = counting period (0000-0600, 0600-1200, 1200-1800, and 1800-2400),
ts = time at start of counting period,
te = time at end of counting period,
OC = oscilloscope counts, and

SC = sonar counts.

The periodic adjustment factor was applied to the unadjusted sonar counts for each hour within the associated calibration period for each bank. The resulting corrected sonar counts for each hour within a day were summed, yielding the estimated summer chum salmon passage for that day for that bank. Corrected hourly counts were calculated and totalled for each day and bank using a portable computer. The daily passage of salmon was determined by summing the daily bank estimates. Daily adjustment or correction factors for each bank and for both banks combined were calculated by dividing the daily corrected counts by the raw sonar counts. Raw sector counts for each day were corrected by using the overall daily correction factor. Corrected hourly and sector counts were used to determine the temporal and spatial distribution of the summer chum salmon run.

Sonar counters do not distinguish between species of salmon. However, a separate escapement estimate for chinook salmon was obtained by aerial survey. This count was not subtracted from the chum salmon sonar count because I assumed that most chinook salmon were not counted by the sonar counters. This assumption was based on tower observations which indicated that in most years, most chinook salmon migrated up the middle of the stream channel beyond the ensonified zones. Additionally, the relative small numbers of chinook salmon annually observed during aerial surveys conducted under fair or good conditions have averaged <0.3% of the estimated sonar counts of summer chum salmon escapement from 1979-1993. In 1994 chinook salmon observed during an aerial survey flight corresponded to a very small portion of the sonar count, <0.1%. Although the survey was conducted under poor conditions and only included the index area, the extremely low percentage of summer chum salmon counts possibly being registered by chinook salmon is inconsequential to the summer chum salmon count.

During the 1994 season pink salmon were observed from the observation tower on each bank. Pink salmon were also captured in beach seine samples. Pink salmon passage was estimated for each bank on each day. The estimated pink salmon passage proportion for each bank for each day was calculated from the total number of pink salmon divided by the total number of chum and pink salmon observed passing that bank on that day.

Tower observations were usually conducted in association with calibration periods on the east bank and immediately after calibration periods on the west bank. Observation of salmon passage on each bank was hampered by glare, which resulted from overcast skies and reflection of the sun off the water, and time of day. On overcast days observation of salmon passage was not possible. When observations were possible, the daily proportion of pink salmon passage was based on the sum of counts during 15-minute observation periods on each bank throughout the day. Number of daily tower observations for each bank ranged from 0 to 6 (Table 4). When counting was not conducted for a full day, the bank-specific pink salmon passage proportion was estimated from a curvilinear equation fitted to the observed data for that bank. The generalized form of the equation is:

$$P_{db} = \left[1 - \beta e^{-\alpha(d - \theta)} \right]^{\left(\frac{1}{\beta}\right)}, \tag{2}$$

where:

P_{db} = proportion of counts attributed to the pink salmon on day d (1,2,3,...), on bank b (west or east)

B, α, θ are parameters to be estimated (J. Bromaghin, Alaska Department of Fish and Game, Anchorage, personal communication).

The parameters of the equation were estimated by minimizing the sum of the squared differences of the observed and predicted proportions using the solver bundled with Microsoft[3] Excel 5.0. The minimization produced estimates of the parameters as follows for the west bank:

B = 0.134358,
α = 0.708416, and
θ = 24.681627.

The minimization produced estimates of the parameters as follows for the east bank:

B = 0.190854,
α = 0.668210 and
θ = 24.468430.

Missing hourly sector counts not recorded as a result of debris or printer malfunction were estimated by averaging the counts in the same sector for the hour before and after the count in question. When hourly counts were not recorded for more than 3 h and less than 12 h within one day, the corrected total daily count for that day was estimated by dividing the corrected partial daily count by the mean proportion of corrected counts for the corresponding hours for the first day before and after the day in question having full 24-h counts. When hourly counts were not recorded for 12 h or more within a day, the passage estimate for that day was estimated by averaging the estimated daily counts for the first day before and after the day in question having full 24-h counts. Estimated counts were not distributed by hour and sector for periods of unrecorded hourly counts which were estimated for a time period of greater than 2 h.

When flooding conditions or equipment malfunction resulted in suspension of counting operations on one bank for a more than one day, daily counts were estimated based on the salmon passage on the opposite bank in conjunction with an estimate of bank-specific passage proportion. During the 1994 season, an average passage proportion to date was used to estimate the daily passage on the east bank when counting was suspended. After the season, however, daily counts for these

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days were estimated based on an estimated east bank passage proportion for each day. Estimated passage proportions for these days were derived by fitting a curvilinear equation to east bank passage proportion data for days with full 24-h counts on both banks over the entire season. The generalized form of the equation is the same as in equation 2:

$$p_d = \left[1 - \beta e^{-\alpha(d - \theta)} \right]^{\left(\frac{1}{\beta}\right)} \qquad (3)$$

where:

P_d = proportion of counts attributed to the east bank on day d (1,2,3,...),
B, α, θ are parameters to be estimated. (J. Bromaghin, Alaska Department of Fish and Game, Anchorage, personal communication).

The parameters of the equation were estimated by minimizing the sum of weighted squared differences of the observed and predicted proportions, using the solver bundled with Microsoft[4] Excel 5.0. The minimization produced estimates of the parameters as follows:

B = -0.375506,
α = 0.0692401, and
θ = 30.297999.

Age-Sex-Size Sampling

Season strata used for the comparison of hourly and sector passage data were defined by the early, early middle, late middle and late strata for age-sex-size sampling goals. Each stratum was initially determined preseason based on historical run timing data; they represent an attempt to sample the escapement for age-sex-size information in relative proportion to the total run. Strata were defined as: 15 June-3 July; 4-8 July; 9-13 July; and 14-27 July. These strata were not adjusted inseason.

A beach seine (31 m long, 66 meshes deep, 6.35-cm mesh) was set approximately 100 m above the sonar site to capture chum and chinook salmon for age, sex, and size measurements. All resident fresh-water fish captured were enumerated by species and released. Pink salmon were enumerated by sex and released. Chum and chinook salmon were placed in a holding pen, enumerated by sex, and measured in millimeters from mid-eye to fork-of-tail. Additionally, one scale was taken for age determination from chum salmon. Three scales were taken from each chinook salmon for determination of age and for use in a stock identification study. Scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left

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side of the fish (Clutter and Whitesel 1956). The adipose fin was clipped on each chum and chinook salmon before release to prevent resampling. Additionally, chinook salmon carcasses were sampled in August to supplement the beach seine sample. Scale samples were later pressed on acetate cards and the resulting impressions viewed on a microfiche reader for age determination.

Sample size goals for each species were based on 95% precision with a 10% accuracy for each time stratum. A sample size of 138 fish per stratum (early, early middle, late middle, and late) was needed to describe the age composition of the chum salmon escapement by stratum (Bromaghin 1993). However, the sample size goal was increased to 160 per stratum to account for unageable scales. A sample size of 198 for the season (1 stratum) was needed to describe the age and sex composition of the chinook salmon escapement based on the number of expected age classes and an assumed 10% unageable rate (Bromaghin 1993). However, a sample size of 400 chinook salmon was deemed necessary for the scale pattern analysis baseline for the Anvik River chinook salmon stock (D. Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication).

Hydrological and Climatological Sampling

A water depth profile was measured at 3-m intervals from established headpins across the width of the river by probing with a pole marked in 1-cm increments. Because the east bank sonar site was initially situated approximately 3 m upriver from the west bank site, one transect situated between the sites served to describe first profile. In late June the east bank site was moved farther upriver and the west bank site farther downriver. Therefore, a transect was necessary to describe each bank-specific profile. Because of time restraints on the crew, transect profile data were collected only two times during the season.

Climatological data were collected at approximately 1800 hours each day at the campsite. Relative river depth was monitored by staff gauge marked in 0.01-ft increments. Change in water depth was converted to centimeters and presented as negative or positive increments from the initial reading of 0.0 cm. Water temperature was measured in degrees centigrade near shore at a depth of about 0.5 m. Daily maximum and minimum air temperatures were recorded in degrees centigrade. Subjective notes were kept by the crew describing wind speed and direction, cloud cover, and precipitation.

Run Timing

Since 1986, except for 1992, run timing of summer chum salmon within the Yukon River drainage was monitored at three locations: the lower Yukon River test fishery (rkm 32), Yukon River sonar site (rkm 198), and Anvik River sonar site (rkm 589) (Figure 1). In 1992, the Yukon sonar project was conducted in an experimental mode, and complete timing statistics are not available.

Run timing statistics, quartile days, were calculated for chum salmon passage at the lower Yukon River test fish, the Yukon River sonar site, and Anvik River sonar site for 1994 and compared. Because the Anvik River is the major producer of summer chum salmon in the Yukon River drainage, comparison of run timing statistics allowed a calculation of estimated migratory rate of salmon between the lower Yukon River test fishery and Yukon River sonar site and the Anvik River sonar site.

RESULTS AND DISCUSSION

Escapement Estimation

Sonar Assessment

Two sonar counters were operated on the Anvik River from 19 June through 23 July at the same sites used in previous years. Only a small portion of the central river channel, approximately 13 m, was not ensonified on 20 June (Figure 3). However, because of increasing river water level during most of the season (Figure 4), and consequent relocation of transducers, the portion of the central river channel not ensonified probably increased over initial transducer placement. Additionally, placement of the east bank transducer was problematic for a large portion of the season. For an eight-day period in late June and a three-day period in mid July, the east bank transducer could not be placed in the water because of high water conditions. When water level conditions allowed the placement of the east bank transducer, the transducer was situated farther inshore than other years. Consequently, the insonified range was reduced by a bar which the transducer was usually placed on in prior years. However, because of increased water velocities, resulting from higher river discharge, chum and pink salmon were observed to migrate very close to the banks during 1994. Therefore, although a larger portion of the central river channel was not ensonified this season, I believe that very few chum and pink salmon migrated beyond the ensonified zone.

The escapement estimate for the period 19 June through 23 July was 1,124,689 summer chum salmon and 252,999 pink salmon (Table 1). Although chum salmon passage was at relatively low levels by 23 July, 1% of the total season passage per day (Figure 5), the pink salmon run was still building (Table 1). The 1994 pink salmon passage estimate through 23 July was more than 3 times larger than the previous highest estimate or approximation of pink salmon escapement to the Anvik River on record. During the years 1972-1979, expanded estimates of pink salmon passage from tower counts exceeded 1,000 salmon in only one year, 1975 (Trasky 1976). In most years since 1979, pink salmon have been observed from the observation towers at the Anvik River sonar site. However, because pink salmon did not generally register as counts on the sonar counter (Buklis 1983) and because of their relatively small passage numbers, estimates of pink escapement were not provided. However, during the 1982 field season, because of a relatively large run of pink salmon in the Anvik River, Buklis (1983) approximated that 76,800 pink salmon passed the sonar site. Starting in 1988, probably because long-range sonar counters were used on the project instead of the shorter range counters used in previous years, pink salmon were observed to register as counts on the sonar counter. Although estimates of pink salmon passage were not reported for the 1988 (Sandone 1989) and 1992 (Sandone 1994a) field seasons, daily estimates of pink salmon passage were subtracted from the sonar counts to more accurately estimate daily summer chum salmon passage. During these years, pink salmon passage was probably between 15,000 and 20,000 salmon during the field season. Because of the relatively very large numbers of pink salmon passing the sonar site during the 1994 season, a separate estimate for pink salmon passage has been provided. However, this is only a partial estimate because counting operations were terminated while the pink salmon escapement was still building. Because hourly and sector counts could not be adjusted to reflect only chum salmon passage, data by hour and sector include both pink and chum salmon passage combined. Note that because the pink salmon migration was later than the chum salmon migration, pink salmon substantially affected the sonar counts only during the last sampling stratum.

Quartile passage days for the summer chum salmon run occurred on 1 July, 7 July, and 11 July (Table 2). Based on historic timing statistics the 1994 chum run was evaluated as slightly early and of average duration (Figure 6). The first and third quartile days were 2 d earlier than the 1979-1993 average, while the median day of passage was 1 d early (Table 2). The duration of the mid-50% portion of the 1994 run lasted 10 d, which is also the 1979-1993 average duration (Table 2). Daily summer chum salmon passage between the first and third quartile days ranged from 38,322 to 88,585 chum salmon. During the remaining 50% of the run, daily passage estimates exceeded 38,000 salmon twice during the first quartile and once during the third quartile (Table 1).

In 1994, passage was greatest during the 7-d period, 5-11 July. This peak passage period included the median day of passage, 7 July, and the third quartile day of passage, 11 July. During this 7-d period, 459,375 salmon, or 41% of the total season escapement, passed the sonar site. Highest daily passage proportion, 0.08, occurred on the third quartile day of passage, 11 July (Table 1). As in 1993, chum salmon were first counted passing the sonar site on 19 June, the earliest on record. However, this is more likely a function of initiation of project operations rather than summer chum salmon run timing. In most years, some salmon pass by the sonar site prior to and after project operations. However, these numbers are small and probably comprise a small percent of the total run.

Buklis (1982a) expanded the season escapement estimates for 1972 through 1978, making it possible to more directly compare visual count estimates to more recent annual sonar count estimates (Figure 7). Assuming an average brood year contribution of 4% age-3, 51% age-4, 34% age-5, and 1% age-6 summer chum salmon, the 1994 escapement estimate of 1,124,689 summer chum salmon was 121% greater than the weighted parent-year escapement from years 1988-1991 of 507,926 fish, and was 74% above the long-term (1972-1993) annual average of 644,857 fish.

A total of 24.77 h of sonar calibration were conducted over the 35-d period from 19 June - 23 July at the west bank site. West bank sonar accuracy (sonar count/oscilloscope count) averaged 1.04 (Table 3). Sonar accuracy averaged 0.99 for 22.82 h of oscilloscope calibration at the east bank site for the same period (Table 3). Additionally, visual counts of salmon by species (Table 4 were conducted from the tower on each bank to apportion the corrected sonar counts by species on each bank.

Buklis (1982b) first noticed a distinct diurnal salmon migration pattern during the 1981 season with a higher proportion of the salmon migration past the sonar site during the evening hours. A similar pattern was observed during the years 1985 through 1993 by Buklis (1985, 1986, 1987) and Sandone (1989, 1990a, 1990b, 1993, 1994a, 1994b). In 1994 temporal distribution of the west (Appendix A) and east (Appendix B) bank adjusted sonar counts by hour also indicated a distinct diel pattern of salmon passage (Figure 8). Based upon adjusted counts for days with full 24-h counts, salmon passage was lowest, less than 4.0% of the daily passage per hour, from 1200 to 2200 hours (averaging 3.1% of the daily passage per hour) and greatest, greater than or equal to 5.0% of the passage, from 0100-0600 (averaging 5.7% of the daily passage per hour). Chum salmon passage between the hours of 7000 - 1100 and from 2300 - 2400 was intermediate, averaging 4.6% of the daily passage per hour. This pattern was relatively consistent throughout the season (Figure 9) and very similar to the historical temporal distribution pattern of the migration.

In all but one year that sonar was used to estimate Anvik River summer chum salmon escapement, a majority of the escapement passage has been associated with the west bank (Mauney and Buklis 1980; Buklis 1981, 1982b, 1983, 1984a, 1984b, 1985, 1986, 1987; Sandone 1989, 1990a, 1990b, 1993, 1994, 1994b). In 1992, only 43% of the total adjusted counts were observed on the west bank (Sandone 1994a). This percentage was very dissimilar to the historical average, and was attributed to very low water conditions which affected salmon migration patterns at the sonar site. In 1994, the salmon migration was considered normal based on temporal and spatial migration data. In 1994, approximately 79.8% of the chum salmon migrated along the west shore (Table 1). The 1985-93 average percent of adjusted counts of salmon which migrated along the west bank is 71%. Additionally, as in previous years, I assumed that only a very small portion of the total summer chum salmon passage was not counted during the operational period. Although high water conditions resulted in the ensonification of a lower percentage of the cross sectional area than usual, I believe that because of associated higher water velocities fewer chum salmon than usual migrated beyond the ensonified zones. Therefore, I believe that this assumption was especially plausible in 1994 considering the relatively high water levels and velocities present. This assumption is supported by the general absence of chum salmon passage in offshore sectors (Figure 8).

Pink and chum salmon passage by hour and sector could not be differentiated. However, total daily counts attributed to chum salmon during each of the four sampling strata were 99.9%, 99.6%, 97.2%, and 43.1%, respectively. Therefore, possible differences in the pink salmon temporal and spatial migration may have substantially affected hourly and sector counts only during the last sampling stratum, 14-23 July. Combined salmon passage along the west bank (Figure 8) was greatest in near-shore sector 2, 35.4%, and decreased in sectors farther offshore (Appendix C). Sectors 1 through 3 accounted for 66.0% of the total salmon passage and 88.1% of the west bank passage estimate. This distribution of salmon passage along the west bank was very similar to previous years. Combined salmon passage along the east bank (Figure 8) did not exhibit the anomalous pattern observed during the 1992 migration, but was very similar to migration patterns observed for years prior to 1992 and for 1993. In those years, near-shore sectors accounted for the majority of the passage along the east bank. In 1994, the three near-shore sectors, sectors 30 -32, accounted for 23.9% of the total 1994 combined salmon passage and 95.3% of the total east bank passage estimate. Distribution among the two east bank near-shore sectors, sectors 31 and 32, was very similar (Figure 8). Together, near-shore sectors 1-3 and 30-32 accounted for 90.0% of the estimated 1994 summer chum and pink salmon passage. The remaining 10.0% passage was distributed over the remaining 26 sectors (Figure 8).

Similar to 1993 (Sandone 1994b), proportion of chum salmon passing along the east bank declined slightly from the first to the second sampling stratum, then increased as the run progressed. This bank-oriented migrational shift is consistent with migration patterns observed in 1990, 1991, and 1993 (Sandone 1990b; 1993, 1994b). During 1992, however, the opposite shift was observed. The 1992 summer chum migration shifted from a dominate east-bank to west bank migration (Sandone 1994a). In 1994, percent of salmon passage along the east bank during the second stratum was 13.6%; percent passage increased to 20.9% during the third stratum; and further increased to 42.3% during the final stratum. During the first stratum in 1994, percent passage along the east bank accounted for an estimated 16.8% of the total stratum passage. However, full 24-h counts were only available for six of the 15 days on the east bank within this sampling stratum (Appendix B and D). Additionally, no hourly counts were available on some days because high water conditions prohibited the placement of the transducer in the water. Estimates for these days were based on the west bank passage estimate and an estimate of the daily passage proportion along the east bank. Because the daily proportion of summer chum salmon which migrate along the east bank increased during the season in a regular manner, the east bank passage proportion estimate was derived from a curvilinear equation fitted to available east bank passage proportion data over the entire season. Therefore, percent passage along the east bank during the first sampling stratum may not be entirely reliable.

Throughout the season, spatial salmon passage along the west bank remained fairly constant, with salmon passage in sector 2 dominating all other sectors (Figure 10). Similarly, salmon migration was predominately onshore along the east bank. Apparent minor shifts in spatial migration pattern was probably caused by placement of the transducer relative to fluctuations in water levels, and not by a shift in the spatial migration pattern of the salmon.

Management Implications Because of the pre-season projection of a below average to critically low summer chum salmon run in 1994, the department managed the Yukon River fisheries very conservatively to reduce mortality of summer chum salmon (ADF&G 1994a). The 1994 management plan (ADF&G 1994b) prescribed that no directed commercial fishing for summer chum salmon would be allowed until it could be determined that a harvestable surplus above escapement and subsistence needs existed. In an effort to be very conservative the assessment during June was based on the earliest run timing model. However, post season analysis indicated the projection based on average run timing was much more accurate (ADF&G 1994a).

On 30 June, the department determined that escapement and subsistence needs would be achieved (ADF&G 1994a). In early July, in conjunction with inseason Yukon River and Anvik River sonar passage estimates, a harvestable surplus of summer chum salmon was identified. Accordingly, a commercial fishing period, restricted to gillnets of 6 inch or less mesh size was scheduled for 4-5 July in District 1. Because this surplus was identified late in the summer commercial fishing season and because of poor market conditions at that time, no other restricted mesh size fishing period was scheduled in the Lower Yukon Area (ADF&G 1994a). The 1994 commercial harvest of 55,236 summer chum salmon in the lower Yukon River fisheries was only 21% of the low end of the combined Lower Yukon Area guideline harvest range of 257,000. The high end of the range is 774,000 salmon.

Inseason Anvik River passage estimates in conjunction with the Yukon River sonar passage estimates also played a major role in the management of the Upper Yukon Area fisheries in 1994. Comparison of passage data from these projects was used to assess summer chum salmon run size above the confluence of the Anvik and Yukon Rivers. Based on these projects, a harvestable surplus of summer chum salmon was identified above the Anvik River in early July. Consequently, four fishing periods were scheduled in Subdistrict 4A for a total fishing time of 90 h. During these four periods approximately 131,262 summer chum salmon were harvested to produce the 62,801 pounds of summer chum salmon roe sold. The 90 h of commercial fishing time allowed in Subdistrict 4A was over 4.25 times the amount of fishing time allowed during the 1993 season but only 16% of the historic fishing schedule, which last occurred during the 1989 season. Consequently, the 1994 commercial harvest in the Subdistrict 4A fishery was slightly above the low end of the guideline harvest range of 113,000 salmon. The high end of the range is 338,000 salmon. Summer chum salmon harvests in Subdistrict 4B and 4C, 15,960 salmon, were slightly below the low of the guideline harvest range of 16,000 - 47,000 fish. No summer chum salmon were commercially harvested in District 5. The District 6 fishery was managed on the results from the counting tower projects on the Chena and Salcha Rivers.

Inseason Anvik River passage estimates also played a major role in allowing a commercial fishery in the newly established Anvik River management area. Because of a large harvestable surplus of Anvik River summer chum salmon, the lower 12 miles of the Anvik River were opened to commercial fishing for six fishing periods. A total of 19,532 pounds of roe were sold from an estimated harvest of 22,573 female summer chum salmon. Incidental catches of chinook salmon appeared to be minimal (ADF&G 1994a).

Based on a preliminary Yukon River sonar passage estimate of approximately 2.0 million summer chum salmon, reported commercial and estimated subsistence harvests, and the estimated escapement to the Anvik River, approximately 600,000 summer chum salmon escaped to tributaries above the Yukon River sonar site, other than to the Anvik River. This escapement level is nearly double the estimated 1993 escapement level. Escapement objectives appeared to have been achieved throughout the drainage. A tower count of 148,762 summer chum salmon on the mainstem Nulato River (Table 5), under less than optimal viewing conditions, suggested that the aerial survey escapement goal for the North Fork Nulato River, of 53,000 chum salmon, was probably achieved. A tower count on the Salcha River of 39,343 summer chum salmon (Table 5) indicated that the aerial survey escapement goal of 3,500 was also probably achieved. Escapement surveys of the two other tributaries which have established escapement goals, Clear and Caribou Creeks of the Hogatza River, were not conducted during 1994. Aerial surveys, tower, and weir counts of escapements to other upper river tributaries, which do not have established escapement goals (Table 5), indicated that summer chum salmon escapement was very good. Further, a weir count of 200,981 summer chum salmon on the East Fork of the Andreafsky River (Table 5) indicated that escapement to lower river tributaries was also good. This evaluation of good river-wide summer chum salmon escapement is much different than the poor escapements observed for spawning stocks, other than the Anvik River, in recent years.

Aerial Survey Assessment

An aerial survey of the Anvik River index area, from the Yellow River to McDonald Creek, was flown on 23 July under poor survey conditions. A total of 913 chinook salmon were enumerated. Summer chum and pink salmon were observed but counts were not conducted on these species. Although survey conditions were poor the resulting chinook salmon count was 80% above the minimum escapement goal of 500 chinook salmon for this index area.

Age and Sex Composition

Summer Chum Salmon

Beach seine sets were made from 27 June to 21 July on 14 individual days. A total of 1,224 summer chum salmon were captured; 648 were sampled for age, sex, size information (Appendix E.) Stratum sampling sizes for summer chum salmon were 163, 162, 160, and 163 for the four sampling strata. Of those fish sampled for scales for age determination, 146, 135, 138, and 141, respectively, had ageable scales. Therefore, the sampling goal of 138 ageable scales per stratum was achieved for the first, third and fourth strata. Ageable scales totaled 135, or 98% of the sampling goal, for the second stratum. Overall, of the 648 chum salmon sampled for age-sex-size data, 86% had ageable scales. The 1994 percentage of ageable scales is slightly lower than expected, 90%, and similar to the 1993 percentage.

Sample sizes have been sufficient since 1989 to examine sex and age composition by sampling stratum. In all years, age and sex of the escapement passing the sonar site has varied through the duration of the run. As in other years since 1989, the same general pattern of an increasing proportion of younger, female salmon was observed during the 1994 run (Figure 11). In 1994 age-5 chum salmon dominated the first three sampling strata (Figure 11), ranging from 76.7% in the first to 57.2% in the third stratum. The proportion of age-5 chum salmon in the final stratum was 50.4%. The proportion of age-4 salmon increased from 21.9% during the first stratum to 47.5% in the final stratum (Figure 11). Age composition of the escapement, weighted by strata escapement counts, was 0.0% age 3, 35.0% age 4, 63.8% age 5, and 1.2% age 6 (Appendix F). The contribution of age-4 salmon, 35.0%, was well below the long-term (1972-1993) average contribution of age-4 salmon to the escapement, 59.4%. Conversely, the contribution of age-5 salmon was well above the long-term average contribution of age-5 salmon to the escapement, 36.5%. The contribution of age-6 salmon was similar to the long-term average contribution of 0.9%, whereas the contribution of age-3 salmon, 0.0% was well below the long-term average contribution of 3.2% (Appendix F). Although a below average to critically low summer chum salmon run was expected for the Yukon River in 1994 (ADF&G 1994b), the run developed better than anticipated. The difference between the projection and actual run size for the drainage appeared to be the unexpected production of age-5 salmon from the 1989 brood year. In 1993, the age-4 salmon return from the 1989 brood year was disappointingly low (Sandone 1994a). However, in the Anvik River, the return of age-5 summer chum salmon from this same brood year in 1994 was much larger than anticipated, resulting in near-normal production from the 1989 brood year.

Age-4 chum salmon dominated the escapement in 15 of the 23 years of record. Age-5 chum salmon dominated the escapement in 1972, 1976, 1981, 1986, 1989, 1991, 1992, and 1994 (Figure 12). However, age-5 salmon dominated the escapement in 4 of the last 6 years. Because of this recent frequent domination of the escapement, and probably the run and return as well, the average age of maturation has increased from 4.29 years (1972-1985 average) to 4.37 years (1972-1994 average; Figure 13). The average age of the Anvik River escapement for the years 1989-1994 is 4.54 years. Bigler and Helle (1994) documented shifts in both average size and age at maturity in Yukon River summer chum salmon. They explain their results by density dependent pressures reducing the food availability during periods of large population numbers of North Pacific salmon in the ocean. They further explain that reduced growth delays the onset of the spawning migration, hence, the apparent increase in the age of maturation.

In 1994, female chum salmon accounted for 58.7% of the escapement to the Anvik River. Females have contributed more than 50% to the summer chum salmon escapement every year since 1979 and for 20 of the 23 years of record (Appendix F). Overall, the female contribution has ranged from 39.1% in 1974 to 69.4% in 1982; the 1972-1993 mean percentage is 57.2%. From 1974 to 1989, the mean running percent female salmon in the Anvik River escapement has increased. However, since 1989 the running average appears to have stabilized (Figure 13).

Similar to recent years (Sandone 1990a, 1990b, 1993, 1994a, 1994b), the female component of the 1994 Anvik River escapement increased as the run progressed. In prior years, male chum salmon usually dominated at least the first sampling stratum, whereas, female salmon dominated at least the final two strata. In 1994, female chum salmon, 55.5%, were slightly more abundant than male salmon, 44.5%, in the first sampling stratum. Percent female and male salmon were nearly equal in the second stratum, 51.0%, and 49.0%, respectively. Percent female chum salmon increased in to 62.5% in the third sampling stratum, and to 70.4% in the final stratum (Figure 11).

Generally, in previous years, age class compositions of both the Anvik River escapement and the District 1 summer chum salmon commercial harvest have been very similar (Figure 14). In 1994 this trend continued. Both escapement and harvest samples contained few age-3 and age-6 salmon, and both were dominated by the age-5 component. The preliminary, weighted age-class composition estimate of the 1994 District 1 summer chum salmon harvest was 0.0% age 3, 34.9% age 4, 58.7% age 5, and 0.3% age 6 (D. Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). Typically, male salmon dominate the District 1 commercial harvest, whereas, female salmon dominate the Anvik River escapement. In 1994, female salmon once again accounted for more than 50% of the escapement, but female salmon also accounted for more than 50% of the harvest as well (Figure 15). Female salmon comprised 52.7% of the 1994 District 1 commercial harvest. Differences between the Anvik River escapement and the harvest can be attributed to other summer chum salmon stocks vulnerable to harvest, the selective nature of the gillnets used in the District 1 fishery, and the disproportionate harvest over the duration of the summer chum salmon run.

Chinook Salmon

No chinook salmon were captured by beach seine. However, 470 chinook salmon carcass samples were collected by boat survey in August. Of the chinook salmon sampled for age-sex-size data, 405 (86%) provided ageable scales. Age composition was 3.0% age 4, 51.9% age 5, 39.8% age 6, and 5.4% age 7 (Figure 16). Females accounted for 42.0% of the sample (Appendix G), slightly greater than the 40.3% long-term average (1972-1993 excluding 1974 when no samples were obtained).

Age composition of the District 1 commercial harvest was approximately 1.9% age 4, 44.3% age 5, 49.0% age 6, and 4.8% age 7. Female chinook salmon accounted for 52.4% of the harvest (D.

Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). Typically, the District 1 commercial catch and Anvik River escapement age composition samples of chinook salmon are quite dissimilar (Figure 17). Anvik River escapement has typically been composed of younger-aged salmon than the District 1 commercial harvest (Figure 17). This difference was also observed in 1994. This difference is most likely due to the differences in age compositions and run strengths of the various chinook stocks present in the lower river during the harvest period and secondarily to the size-selective nature of the commercial gillnets.

Hydrologic and Climatological Sampling

River transect data collected on 20 and 28 June indicates that the bottom gradient was relatively smooth on both banks and free of major obstructions to the sonar beam (Figure 3). River width data collected in conjunction with the transect profiles varied from approximately 101 m on 28 June associated with the west bank profile to 92 m on 20 June. Maximum depth, and probably maximum river width, occurred on 15 July (Appendix H). Unlike previous years, river water level varied throughout the season. Usually, river water level drops in a consistent and regular manner throughout the season. However, because of frequent rain during the 1994 season, the Anvik River rose 77.7 cm between 19 June and 15 July in an irregular manner. After 15 July until 23 July, the river water level dropped 47.8 cm to 29.9 cm above the initial measurement on 19 June (Figure 4; Appendix H).

Instantaneous water temperature ranged from a low of 9° C recorded on 22, 23, and 28 June, to a high of 17° C recorded on 17 July. Daily minimum and maximum air temperatures ranged from a minimum low of -2° C, observed on 28 June, to a maximum high of 25° C, observed on 18 July (Figure 4; Appendix H).

Run Timing

The day on which salmon were first counted at the Anvik River sonar site in 1994, 19 June, was the earliest on record along with 1993 (Table 2). All 1994 quartile days of run passage were earlier than long-term (1979-1993) averages. The first quartile day, 1 July, and third quartile day of run passage, 11 July were 2 d earlier than average (Table 2). The median day of run passage was 1 d earlier than average. The duration of the mid-50% of the run lasted 10 d, very similar to the long-term average duration of this statistic, 10.2 d. Therefore, the Anvik River summer chum salmon run at the sonar site was assessed as slightly early, but of average duration (Figure 6).

Summer chum salmon run timing at the lower Yukon River set gillnet test fishery (rkm 32), at the Yukon River sonar site (rkm 198), and at the Anvik River sonar site (589 rkm) (Figure 1) were compared to provide a qualitative assessment of summer chum salmon migration through the lower river fisheries (Figure 18). In 1994, the USFWS operated a weir on the East Fork Andreafsky River. During the period 29 June - 1 August, 200,981 summer chum salmon passed the weir site. Daily passage proportions were calculated for these summer chum salmon weir counts and also presented in Figure 18.

The East Fork Andreafsky River weir site and the Anvik River sonar site are separated by approximately 400 km. However, historic timing data indicates that summer chum salmon timing into this river is very similar to migration timing of summer chum salmon at the Anvik River sonar site. Although the summer chum salmon count at the Andreafsky River weir site was initiated after the run had started, comparison of the timing statistics indicated that the median day of passage differ by only 1 day. However, the passage of the mid-50% portion of the East Fork Andreafsky River summer chum salmon run was 3 days later than the mid-50% portion of the Anvik River chum run. If I assume that the timing of the first quartile day of Andreafsky River run passage actually occurred on 1 July, I can speculate that the number of chum salmon which passed the weir site before counts began was approximately 24,000 salmon. Based on this number, I further speculate that the total summer chum salmon passage up the East Fork of the Andreafsky River was approximately 225,000 salmon. Because aerial survey escapement goals for the East (109,000 salmon) and West (116,000 salmon) Fork Andreafsky River are very similar, it is assumed that 50% of the total Andreafsky River escapement was represented by the East Fork in 1994.

Although the Andreafsky River is situated between the lower Yukon River test fishery and the mainstem Yukon River sonar site, it has been assumed in previous years that most of the unharvested salmon migrating past the lower Yukon River test fishing sites also pass the Yukon River sonar site. However, because of the relatively large number of chum salmon which passed the East Fork Andreafsky River weir in 1994, this may not be a valid assumption for this year. This may be especially true during the latter-50% portion of the run. The latter-50% of the passage at the lower Yukon River test fish site probably included a substantial number of salmon which were destined to the Andreafsky River. Inspection of the graphs in Figure 18 indicates that the large final pulse of summer chum salmon detected in the lower Yukon River test fish catch during early July did not produce a pulse of similar magnitude at the Yukon River or the Anvik River sonar site. A plausible explanation to this inconsistency is that these late-arriving salmon were destined to the Andreafsky River. It is interesting to note that this pulse in the test fish graph corresponds to the mid-50% portion of the Andreafsky River chum salmon run. The relatively large number of salmon returning to the Andreafsky River in 1994 probably resulted in an extended duration for the passage of the mid-50% portion of the run at lower Yukon River test fish sites. Duration of the mid-50% of the run at the lower Yukon test fish sites was 17 d in 1994. Average (1986-1991 & 1993) duration of the mid-50% portion of the run at the test fish site, 14.9 d, has historically been longer than at the Yukon River sonar site, 11.9 d, and Anvik River sonar site, 11.3 d.

Timing statistics of the summer chum salmon migration at the Yukon River and Anvik River sonar sites correspond fairly well (Figure 18), based on an assumed 10 d travel period. Although, the duration of the mid-50% portion was 2 d longer at the Yukon River sonar site, the median days of run passage were 10 days apart, as expected. In 1994, 57% of the estimated summer chum salmon run which passed the mainstem Yukon River sonar site also passed the Anvik River sonar site. This percentage is remarkably similar to the 1993 percentage of 55% (Sandone 1994b).

Because I assume that a majority of the summer chum salmon pass both sonar sites, I can subjectively assess run timing of the summer chum salmon run between these sites. The median date of the 1994 summer chum salmon passage was 27 June at the Yukon River sonar site and 7 July at the Anvik River sonar site. Based on these data, the difference, or lag time between the Yukon River and Anvik River sonar sites was 10 d (1986-1991 & 1993 average = 9.3 d, SE = 1.6). Based on distance and time between median days of passage, the calculated swimming speed of summer chum salmon in 1994 was 38 km/d between the two sonar sites. Since 1986, the calculated swimming speed for summer chum salmon between the two sonar sites, based on the median day of passage at each site, has ranged from 32 to 47 km/d, and has averaged 42 km/d (SE = 6). These calculations, however, may be affected by a number of factors, including accuracy of assessment at the two sonar sites and differences in run strengths and run timing of the various summer chum salmon stocks of the Yukon River drainage.

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TABLES

Table 1. Anvik River sonar counts by day, 19 June - 23 July, 1994.

	West Bank				East Bank				Entire River				
	Raw	Corrected	Counts Attributed to		Raw	Corrected	Counts Attributed to		Raw	Corrected	Counts Attributed to		
Date	Daily	Daily	Chum	Pink	Daily	Daily	Chum	Pink	Daily	Daily	Chum Salmon		Pink
	Count[a]	Count[b]	Salmon	Salmon	Count[a]	Count[b]	Salmon	Salmon	Count[a]	Count[b]	Daily	Cumulative	Daily
19-Jun [c]	279	279	279	0	6	0	0	0	6	279	279	279	0
20-Jun	1,424	1,372	1,372	0	20	20	20	0	1,444	1,392	1,392	1,671	0
21-Jun	2,313	2,280	2,280	0	58	36	36	0	2,371	2,316	2,316	3,987	0
22-Jun	3,165	2,399	2,399	0	22 [d]	90	90	0	3,187	2,489	2,489	6,476	0
23-Jun	0 [f]	9,297	9,297	0	0 [f]	397	397	0	0	9,694	9,694	16,170	0
24-Jun	9,827 [d]	16,195	16,195	0	0 [f]	790	790	0	9,827	16,985	16,985	33,155	0
25-Jun	18,966 [d]	25,377	25,377	0	0 [f]	1,412	1,412	0	18,966	26,789	26,789	59,944	0
26-Jun	38,625	36,564	36,564	0	0 [f]	2,315	2,315	0	38,625	38,879	38,879	98,823	0
27-Jun	32,873	31,070	30,573	497	0 [f]	2,234	2,234	0	32,873	33,304	32,807	131,630	497
28-Jun	22,081	22,713	22,713	0	0 [f]	1,850	1,850	0	22,081	24,563	24,563	156,193	0
29-Jun	16,051	15,272	15,272	0	0 [f]	1,407	1,407	0	16,051	16,679	16,679	172,872	0
30-Jun	18,851 [d]	37,059	37,059	0	12,918 [d]	3,851	3,851	0	31,769	40,910	40,910	213,782	0
01-Jul	48,113	47,828	47,828	0	26,707	27,754	27,754	0	74,820	75,582	75,582	289,364	0
02-Jul	37,261	37,767	37,767	0	12,623	12,521	12,521	0	49,884	50,288	50,288	339,652	0
03-Jul	30,604	29,443	29,443	0	8,870	8,879	8,879	0	39,474	38,322	38,322	377,974	0
04-Jul	21,341	19,246	19,246	0	5,549	5,415	5,415	0	26,890	24,661	24,661	402,635	0
05-Jul	48,887	47,409	47,409	0	6,926	6,833	6,833	0	55,813	54,242	54,242	456,877	0
06-Jul	0 [f]	46,313	46,313	0	6,324	6,542	6,542	0	6,324	52,855	52,855	509,732	0
07-Jul	46,860	45,217	44,629	588	6,341	6,552	6,552	0	53,201	51,769	51,181	560,913	588
08-Jul	76,415	73,526	73,158	368	12,952	11,183	11,183	0	89,367	84,709	84,341	645,254	368
09-Jul	47,159	44,511	44,511	0	13,162	13,007	12,565	442	60,321	57,518	57,076	702,330	442
10-Jul	53,658	53,979	53,115	864	17,283	17,980	17,980	0	70,941	71,959	71,095	773,425	864
11-Jul	82,493	76,269	76,269	0	12,287	12,316	12,316	0	94,780	88,585	88,585	862,010	0
12-Jul	43,315	38,247	37,100	1,147	9,232	9,095	8,695	400	52,547	47,342	45,795	907,805	1,547
13-Jul	30,507	27,280	23,188	4,092	0 [f]	11,436	9,835	1,601	30,507	38,716	33,023	940,828	5,693
14-Jul	25,359	24,177	19,656	4,521	0 [f]	11,150	8,363	2,787	25,359	35,327	28,019	968,847	7,308
15-Jul	16,541	16,680	12,560	4,120	0 [f]	8,451	5,442	3,009	16,541	25,131	18,002	986,849	7,129
16-Jul	13,793	13,819	7,725	6,094	5,839 [d]	9,717	5,743	3,974	19,632	23,536	13,468	1,000,317	10,068
17-Jul	26,922	27,741	16,478	11,263	18,269	19,396	8,554	10,842	45,191	47,137	25,032	1,025,349	22,105
18-Jul	30,301	30,549	16,924	13,625	27,369	28,202	10,266	17,936	57,670	58,751	27,190	1,052,539	31,561
19-Jul	31,178	31,893	15,755	16,138	32,439	29,693	10,393	19,300	63,617	61,586	26,148	1,078,687	35,438
20-Jul	27,774	20,610	7,090	13,520	24,688	22,463	4,672	17,791	52,462	43,073	11,762	1,090,449	31,311
21-Jul	14,675	15,123	5,308	9,815	9,082	8,879	2,104	6,775	23,757	24,002	7,412	1,097,861	16,590
22-Jul	26,370	28,022	9,415	18,607	22,484	23,416	4,777	18,639	48,854	51,438	14,192	1,112,053	37,246
23-Jul	27,220	28,605	7,094	21,511	28,180	28,275	5,542	22,733	55,400	56,880	12,636	1,124,689	44,244
Total	971,201	1,024,131	897,361	126,770	319,630	353,557	227,328	126,229	1,290,552	1,377,688	1,124,689		252,999
Percent[g]	75.3	74.3	79.8	50.1	24.8	25.7	20.2	49.9	100.0	100.0	100.0		100.0

[a] Does not include estimates for missing hourly or daily counts.
[b] Includes estimates for missing counts.
[c] Counting operations were initiated on the west bank on 19 June at 1900 hours and on east the bank on 19 June at 1600 hours.
[d] Counting operations interrupted resulting in a partial daily count. Missing count data were estimated. See Appendix A and B for more information.
[f] Daily count unavailable. Daily bank-specific passage was estimated. See Appendix A and B for more information.
[g] Percent of entire river counts.

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Table 2. Annual Anvik River sonar passage estimates and associated passage timing statistics of the summer chum salmon run, 1979-1994.

Year	Sonar Passage Estimate	Day of First Salmon Counts	First Quartile Day	Median Day	Third Quartile Day	Days Between Quartile Day		
						First & Median	Median & Third	First & Third
1979	277,712	23-Jun	02-Jul	08-Jul	12-Jul	6	4	10
1980	482,181	28-Jun	06-Jul	11-Jul	16-Jul	5	5	10
1981	1,479,582	20-Jun	27-Jun	02-Jul	07-Jul	5	5	10
1982	444,581	25-Jun	07-Jul	11-Jul	14-Jul	4	3	7
1983	362,912	21-Jun	30-Jun	07-Jul	12-Jul	7	5	12
1984	891,028	22-Jun	05-Jul	09-Jul	13-Jul	4	4	8
1985	1,080,243	05-Jul	10-Jul	13-Jul	16-Jul	3	3	6
1986	1,085,750	21-Jun	29-Jun	02-Jul	06-Jul	3	4	7
1987	455,876	21-Jun	05-Jul	12-Jul	16-Jul	7	4	11
1988	1,125,449	21-Jun	30-Jun	03-Jul	09-Jul	3	6	9
1989	636,906	20-Jun	01-Jul	07-Jul	13-Jul	6	6	12
1990	403,627	22-Jun	02-Jul	07-Jul	15-Jul	5	8	13
1991	847,772	21-Jun	01-Jul	10-Jul	16-Jul	9	6	15
1992	775,626	29-Jun	05-Jul	08-Jul	12-Jul	3	4	7
1993	517,409	19-Jun	05-Jul	12-Jul	18-Jul	7	6	13
1994	1,124,689	19-Jun	01-Jul	07-Jul	11-Jul	6	4	10
Mean [a]	724,444 [b]	23-Jun	03-Jul	08-Jul	13-Jul	5.3	4.9	10.2
SE [a]	351,184 [b]	4.5	3.4	3.3	3.0	1.8	1.4	2.6

[a] The mean and SE of the timing statistics includes estimates from years 1979-1985 and 1987-1993. In 1986, sonar counting operations were terminated early, probably resulting in the incorrect calculation of the quartile statistics. Therefore, the 1986 run timing statistics were excluded from the calculation of the overall mean timing statistic and associated SE.

[b] Includes 1986 passage data.

Table 3. Sonar and corresponding oscilloscope counts of salmon at the Anvik River west and east bank sonar sites, 1994.

	West Bank Sonar Site				East Bank Sonar Site			
Date	Elasped Time (hrs:min)	Sonar Count	Scope Count	Sonar/ Scope	Elasped Time (hrs:min)	Sonar Count	Scope Count	Sonar/ Scope
19-Jun	00:15	4	4	1.00	00:45	2	0	
20-Jun	01:00	73	72	1.01	00:45	7	0	
21-Jun	01:00	114	102	1.12	01:15	1	0	
22-Jun	01:30	203	154	1.32	00:15	0	0	
23-Jun	00:00				00:00			
24-Jun	01:23	676	694	0.97	00:00			
25-Jun	00:50	568	517	1.10	00:00			
26-Jun	00:29	693	606	1.14	00:00			
27-Jun	00:29	328	310	1.06	00:00			
28-Jun	01:01	819	832	0.98	00:00			
29-Jun	01:35	573	558	1.03	00:00			
30-Jun	00:26	728	626	1.16	00:44	547	565	0.97
01-Jul	00:23	507	506	1.00	00:19	285	306	0.93
02-Jul	00:28	396	412	0.96	04:03	435	436	1.00
03-Jul	01:30	636	609	1.04	01:12	299	303	0.99
04-Jul	00:30	167	200	0.84	00:15	91	88	1.03
05-Jul	00:46	774	725	1.07	01:01	260	251	1.04
06-Jul	00:20	534	501	1.07	01:00	235	247	0.95
07-Jul	00:37	409	384	1.07	01:15	272	289	0.94
08-Jul	00:14	570	550	1.04	00:52	335	352	0.95
09-Jul	00:29	398	373	1.07	01:21	433	435	1.00
10-Jul	00:32	701	707	0.99	00:40	397	406	0.98
11-Jul	00:27	639	534	1.20	00:43	361	369	0.98
12-Jul	00:35	810	707	1.15	00:52	326	318	1.03
13-Jul	00:36	585	510	1.15	00:00			
14-Jul	01:17	700	713	0.98	00:00			
15-Jul	00:57	435	435	1.00	00:00			
16-Jul	01:03	504	528	0.95	00:58	359	360	1.00
17-Jul	00:31	472	504	0.94	01:10	604	612	0.99
18-Jul	00:28	403	409	0.99	00:41	699	715	0.98
19-Jul	00:37	410	403	1.02	00:20	452	411	1.10
20-Jul	00:37	510	504	1.01	00:32	558	502	1.11
21-Jul	00:34	287	303	0.95	00:53	335	326	1.03
22-Jul	00:39	479	499	0.96	00:32	507	536	0.95
23-Jul	00:38	458	504	0.91	00:26	481	501	0.96
Total	24:46	16,563	15,995		22:49	8,281	8,328	
Mean				1.04				0.99

Table 4. Tower counts of upstream salmon pasage by bank, day, time and species, Anvik River, 1994

West Bank Tower Observations						East Bank Tower Observations					
		Summer Chum	Pink Salmon		Chinook			Summer Chum	Pink Salmon		Chinook
		Salmon		Daily	Salmon			Salmon		Daily	Salmon
Date	Time	Numbers	Numbers	Proportion	Numbers		Time	Numbers	Numbers	Proportion	Numbers
19-Jun											
20-Jun						20-Jun					
21-Jun						21-Jun					
22-Jun						22-Jun					
23-Jun						23-Jun					
24-Jun						24-Jun					
25-Jun						25-Jun					
26-Jun	12:30	100	0	0.000	0	26-Jun					
	17:49	80	0		0						
	23:52	63	0		0						
27-Jun	12:13	45	0	0.016	0	27-Jun	12:00	0	0		0
	17:55	82	2		2						
28-Jun	17:24	86	0	0.000	0	28-Jun	17:45	27	0		0
29-Jun	11:43	42	0	0.000	0	29-Jun	17:50	14	0	0.000	0
	13:42	54	0		0		23:45	373	0		0
	15:45	50	0		0						
	17:35	109	0		0						
	17:50	104	0		0						
30-Jun	18:01	93	0	0.000	0	30-Jun	09:06	329	0	0.000	0
							10:18	113	0		0
							11:37	100	0		0
							11:48	55	0		0
							16:49	100	0		0
							18:20	101	0		0
01-Jul						01-Jul					
02-Jul	11:46	55	0	0.000	0	02-Jul	12:08	46	0	0.000	0
							19:25	100	0		0
03-Jul						03-Jul					
04-Jul						04-Jul					
05-Jul						05-Jul					
06-Jul						06-Jul					
07-Jul	10:30	137	3	0.013	0	07-Jul	10:52	31	0	0.000	0
	11:43	68	1		0		12:10	26	0		0
	17:42	95	0		0		18:15	45	0		0
08-Jul	11:55	86	1	0.005	0	08-Jul	12:10	44	0	0.000	0
	12:05	96	0		0						
09-Jul	11:35	230	0	0.000	2	09-Jul	12:25	69	0	0.034	0
	17:45	50	0		0		18:18	51	5		1
							18:35	48	1		1
10-Jul	19:03	102	3	0.016	0	10-Jul	18:10	100	0	0.000	1
	19:06	87	0		0						
11-Jul						11-Jul					
12-Jul	17:46	300	9	0.030	0	12-Jul	12:35	45	2	0.044	0
13-Jul	11:47	84	14	0.150	1	13-Jul					
	12:10	91	16		0						
	14:35	88	18		0						
	17:40	121	20		0						
14-Jul	06:16	180	23	0.187	0	14-Jul					
	12:01	86	29		2						
	13:35	144	42		1						

continued

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Table 4. (page 2 of 2.)

		West Bank Tower Observations						East Bank Tower Observations			
		Summer Chum	Pink Salmon		Chinook			Summer Chum	Pink Salmon		Chinook
Date	Time	Salmon Numbers	Numbers	Daily Proportion	Salmon Numbers	Date	Time	Salmon Numbers	Numbers	Daily Proportion	Salmon Numbers
15-Jul	06:10	153	39	0.247	0	15-Jul					
	10:01	110	36		0						
	12:04	138	30		1						
	13:17	112	39		2						
	18:00	114	45		0						
	23:42	131	59		0						
16-Jul	07:16	131	71	0.441	0	16-Jul	10:08	49	20	0.409	0
	11:47	58	41		0		12:15	38	46		1
	14:45	28	32		0		15:50	46	44		0
	17:36	58	70		0		18:35	59	23		0
	23:36	96	79		0						
17-Jul	00:10	88	62	0.406	0	17-Jul	12:20	66	122	0.559	0
	12:26	79	52		0		14:16	34	61		0
	17:52	126	76		0		18:20	108	106		0
	23:20	120	92		0		23:50	59	50		0
18-Jul	06:40	134	96	0.446	0	18-Jul	06:15	102	163	0.636	0
	09:43	88	33		2		08:40	84	149		0
	11:20	48	36		0		12:20	69	114		1
	15:30	95	47		0		13:09	39	66		1
	17:25	102	135		0		15:05	76	201		0
	18:17	116	170		0		19:20	164	240		1
	23:31	216	127		0						
19-Jul	05:55	80	46	0.506	0	19-Jul	00:06	109	145	0.650	0
	12:10	70	42		0		06:35	76	129		0
	14:45	52	33		3		12:09	151	297		1
	17:33	66	56		0		14:45	104	210		2
	23:21	23	121		0		19:45	103	229		2
20-Jul	05:52	39	92	0.656	0	20-Jul	00:07	84	170	0.792	0
	11:00	80	109		0		06:26	44	172		0
	23:10	47	115		0		12:01	33	231		0
							18:01	33	229		0
							00:03	59	162		0
21-Jul	06:03	23	58	0.649	0	21-Jul	06:20	11	94	0.763	0
	11:22	30	59		0		11:22	10	127		0
	15:13	25	35		0		14:39	18	72		0
	17:28	55	51		0		18:09	58	73		0
	23:35	41	119		0		00:26	48	102		0
22-Jul	05:25	68	64	0.664	0	22-Jul	06:04	32	117	0.796	0
	11:30	76	115		0		12:13	58	303		0
	17:30	94	155		0		18:10	68	198		0
	23:14	36	208		0						
23-Jul	05:50	63	102	0.752	0	23-Jul	00:03	180	397	0.804	0
	11:37	45	168		0		06:30	33	262		0
	17:25	76	148		0		12:29	38	247		0
	23:20	38	254		0		18:07	22	171		0
							23:20	43	220		0
Totals	73	6,476	3,798		16	Totals	58	4,225	5,770		12

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Table 5. Summer chum salmon escapement counts for selected spawning areas in the Yukon River drainage, 1973-1994.

	Andreafsky River			Anvik River			Kaltag Cr.	Nulato River					Hogatza River[a]					
	East Fork							Aerial		Mainstem	Gisasa River		(Clear &		Chena River		Salcha River	
Year	Aerial[a]	Sonar, Tower, or Weir Cnts	West Fork[a]	Tower & Aerial[b]	Sonar	Rodo River[a]	Tower Counts	South Fork	North Fork[c]	Tower Counts	Aerial	Weir	Caribou Creeks)	Tozitna River[a]	Aerial	Tower	Aerial	Tower
1973	10,149 [d]		51,835	249,015											79 [d]		290	
1974	3,215 [d]		33,578	411,133		16,137		29,016	29,334		22,022			1,823	4,349		3,510	
1975	223,485		235,954	900,967		25,335		51,215	87,280		56,904		22,355	3,512	1,670		7,573	
1976	105,347		118,420	511,475		38,258		9,230 [d]	30,771		21,342		20,744	725 [d]	685		6,484	
1977	112,722		63,120	358,771		16,118		11,385	58,275		2,204 [d]		10,734	761 [d]	610		677 [d]	
1978	127,050		57,321	307,270		17,845		12,821	41,659		9,280 [d]		5,102	2,262	1,609		5,405	
1979	66,471		43,391		280,537			1,506	35,598		10,962		14,221		1,025 [d]		3,060	
1980	36,823 [d]		114,759		492,676			3,702 [d]	11,244 [d]		10,388		19,786	580	338		4,140	
1981	81,555	147,312 [g]			1,486,182			14,348							3,500		8,500	
1982	7,501 [d]	181,352 [g]	7,267 [d]		444,581						334 [d]		4,984 [d]	874	1,509		3,756	
1983		110,608 [g]			362,912			1,263 [d]	19,749		2,356 [d]		28,141	1,604	1,097		716 [d]	
1984	95,200 [d]	70,125 [g]	238,565		891,028								184 [d]		1,861		9,810	
1985	66,146		52,750		1,080,243	24,576		10,494	19,344		13,232		22,566	1,030	1,005		3,178	
1986	83,931	167,614 [h]	99,373		1,189,602			16,848	47,417		12,114			1,778	1,509		8,028	
1987	6,687 [d]	45,221 [h]	35,535		455,876			4,094	7,163		2,123		5,669 [d]		333		3,657	
1988	43,056	68,937 [h]	45,432		1,125,449	13,872		15,132	26,951		9,284		6,890	2,983	432		2,889 [d]	
1989	21,460 [d]				636,906										714 [d]		1,574 [d]	
1990	11,519 [d]		20,426 [d]		403,627	1,941 [d]		3,196 [d, j]	1,419 [d]		450 [d]		2,177 [d]	36	245 [d]		450 [d]	
1991	31,886		46,657		847,772	3,977		13,150	12,491		7,003		9,947	93	115 [d]		154 [d]	
1992	11,308 [d]		37,808 [d]		775,626	4,465		5,322	12,358		9,300		2,986	794	848 [d]		3,222	
1993	10,935 [d]		9,111 [d]		517,409	7,867		5,486	7,698		1,581			970	168	5,487	212	5,563
1994 [y]		200,981 [n, p]			1,124,689		47,615			148,762 [r]	6,827	51,116 [s]			1,137	10,108	4,679	39,343
E.O.[t]	>109,000		>116,000		>500,000[v]				>53,000[x]				>17,000[x]				>3,500	

[a] Data obtained by aerial survey unless otherwise noted. Only peak counts are listed. Latest table revision March 14, 1995.
[b] From 1972-1979 counting tower operated; escapement estimate listed is the tower counts plus expanded aerial survey counts below the tower (see Buklis 1982).
[c] Includes mainstem counts below the confluence of the North and South Forks, unless otherwise noted.
[d] Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.
[f] Boat survey
[g] Sonar count.
[h] Tower count.
[j] Mainstem counts below the confluence of the North and South Forks Nulato River included in the South Fork counts.
[k] Tower Count
[n] Weir Count
[p] Weir installed on June 29. First full day of counts occurred on June 30.
[r] Tower counts delayed until June 29 because of high, turbid water. First full day of counts occurred on June30.
[s] Weir installed on July 11. First full day of counts occurred on July 12.
[t] Interim escapement objective.
[v] The Anvik River Escapement Objective was rounded upward to 500,000 from 487,000 in March, 1992.
[w] Interim escapement objective for North Fork Nulato River only.
[x] Consists of Clear and Caribou Creeks interim escapement objectives of 9,000 and 8,000, respectively.
[y] Preliminary.

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FIGURES

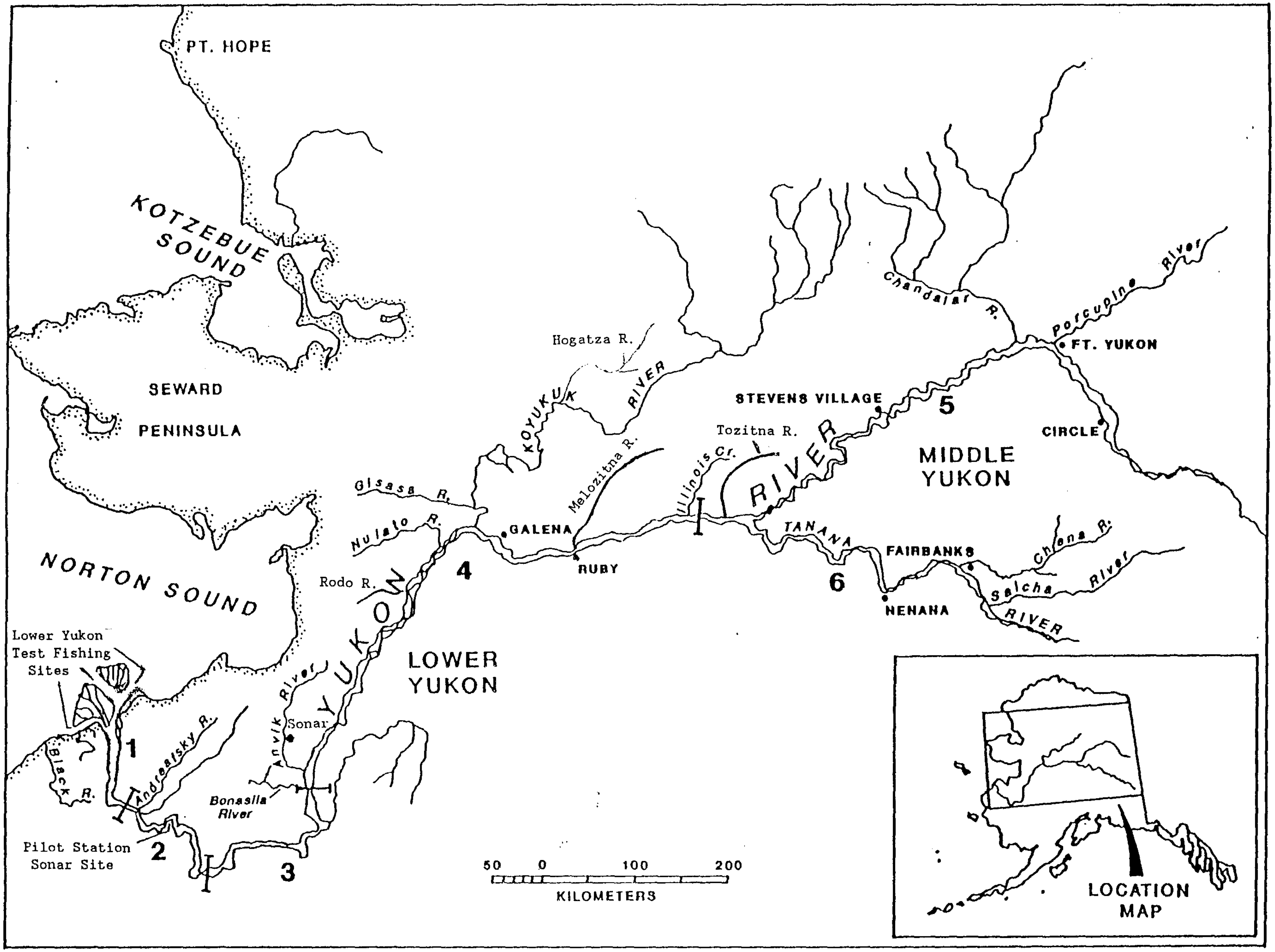

Figure 1. Alaskan portion of the Yukon River showing fishing district boundaries.

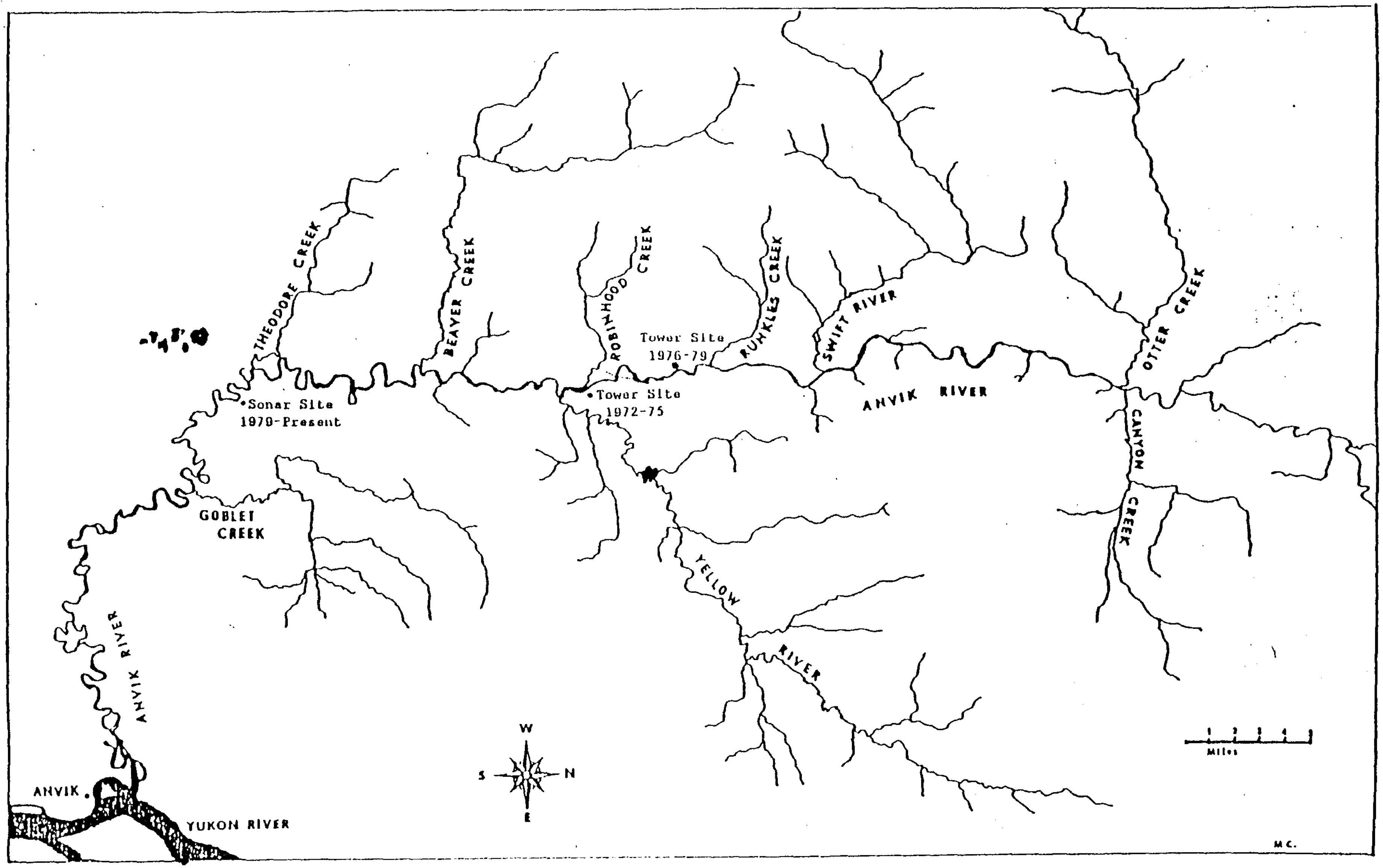

Figure 2. The Anvik River drainage showing sonar and counting tower sites.

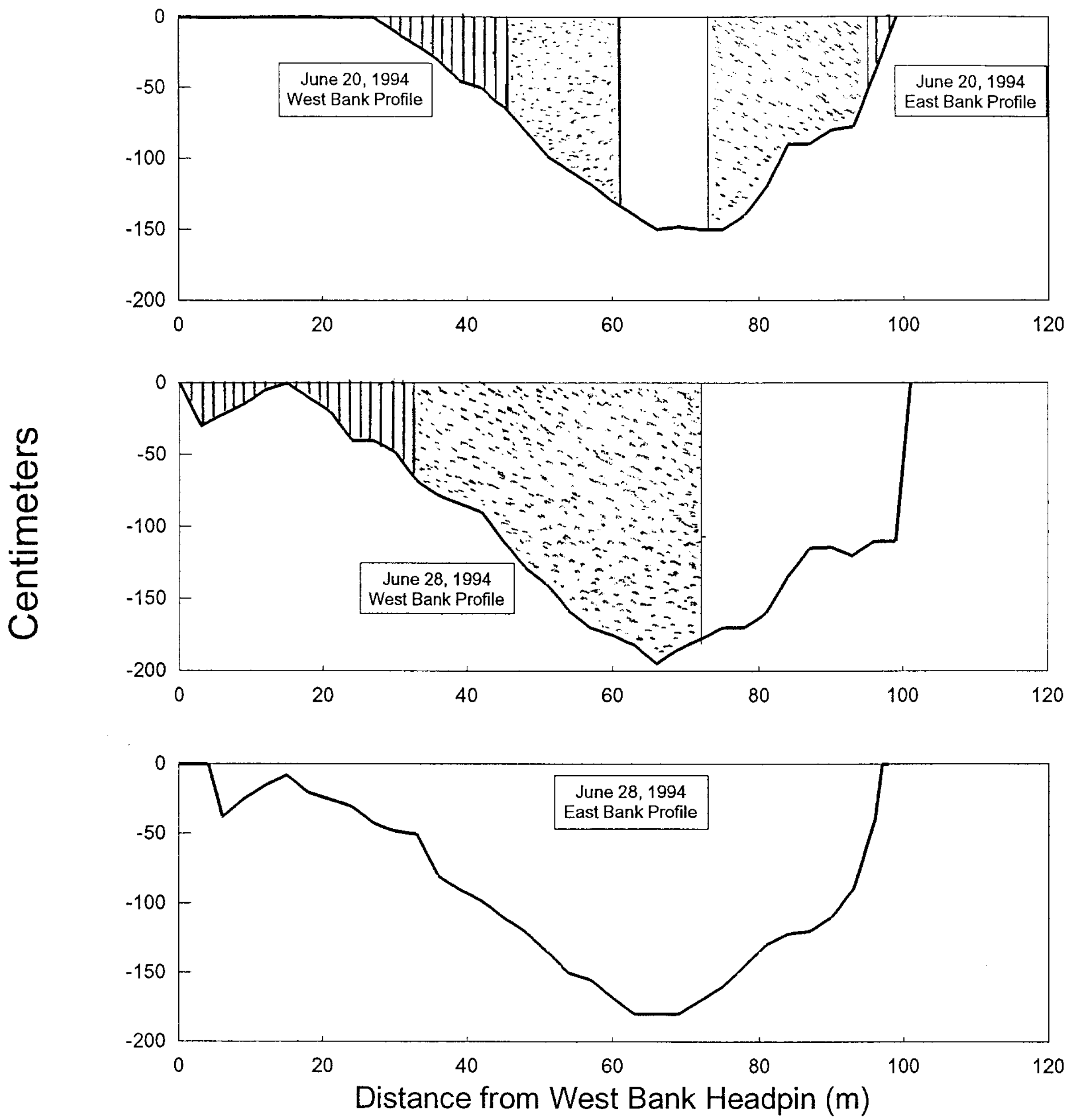

Figure 3. Anvik River depth profiles, 20 and 28 June, 1994. Note that on 28 June the east bank sonar was not installed because of high water. Stippled areas are approximate insonfication zones; weired areas are indicated by vertical lines.

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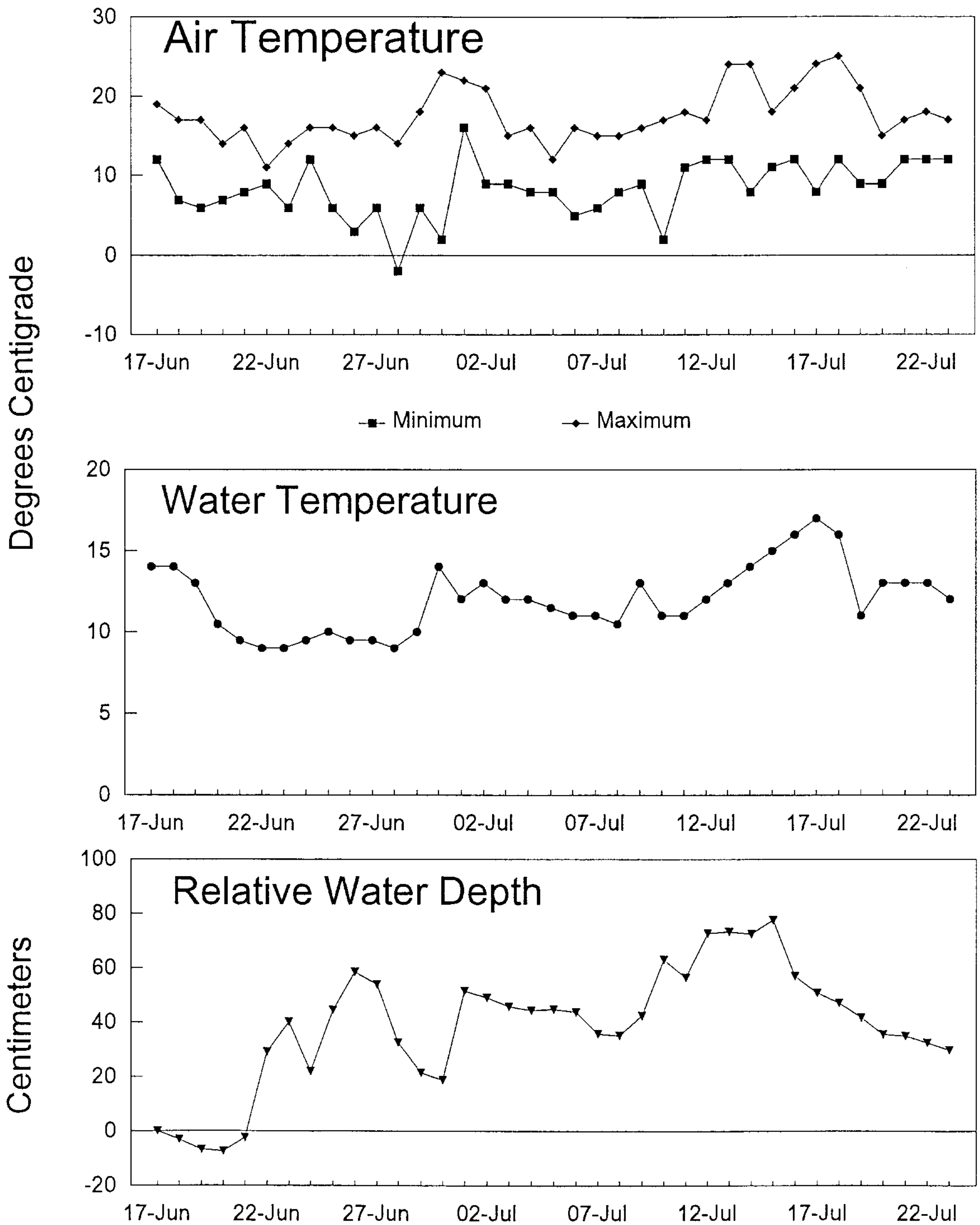

Figure 4. Daily minimum and maximum air temperatures, instantaneous water temperature, and relative water depth measured at approximately 1800 hours daily at the Anvik River sonar site, 1994.

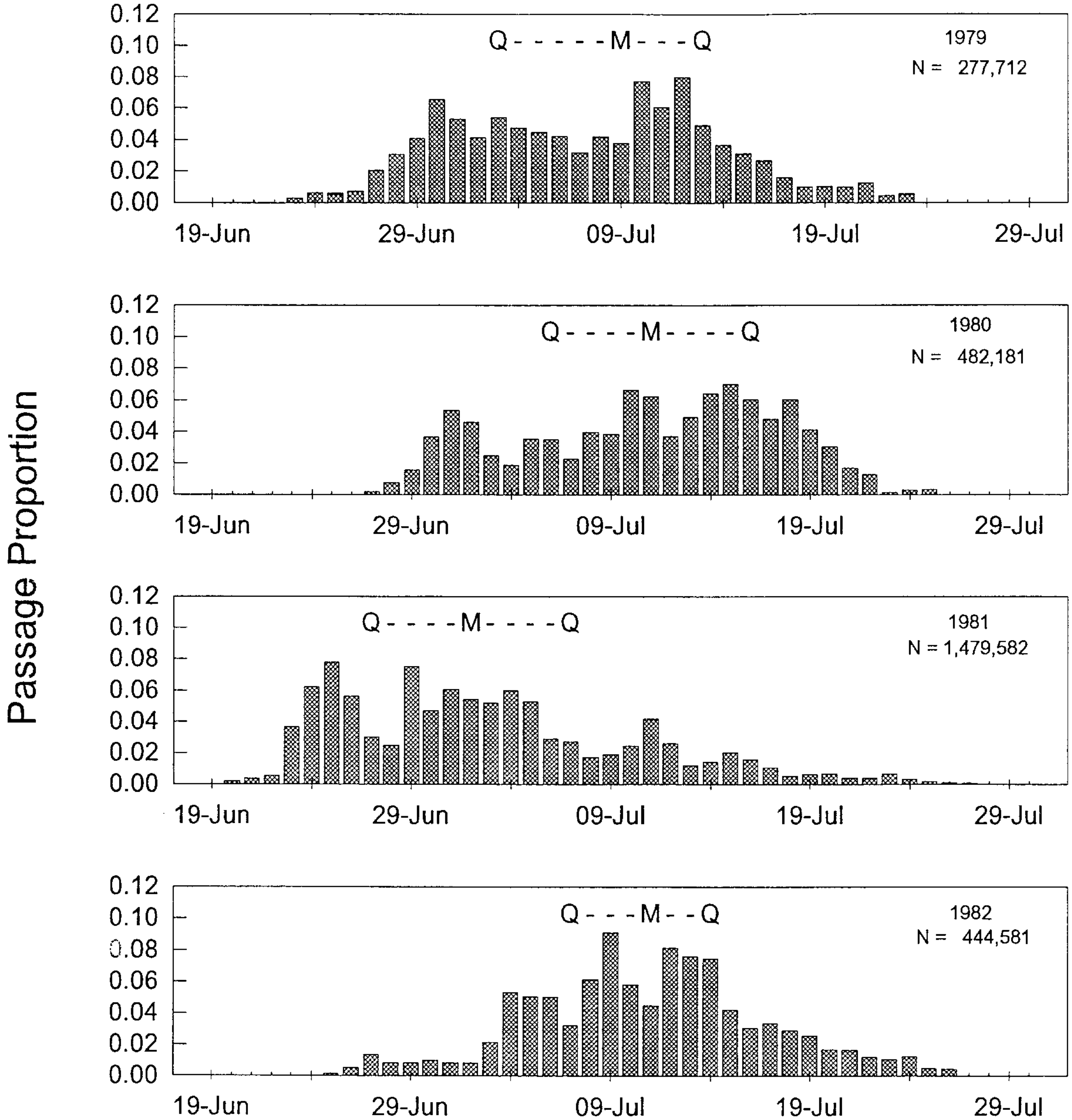

Figure 5. Daily proportion of corrected Anvik River sonar counts of summer chum salmon passage by day, 1979-1994 (N = total number of corrected counts). The first and third quartile passage days are indicated by the "Q"s, while the median day of passage is indicated by the "M".

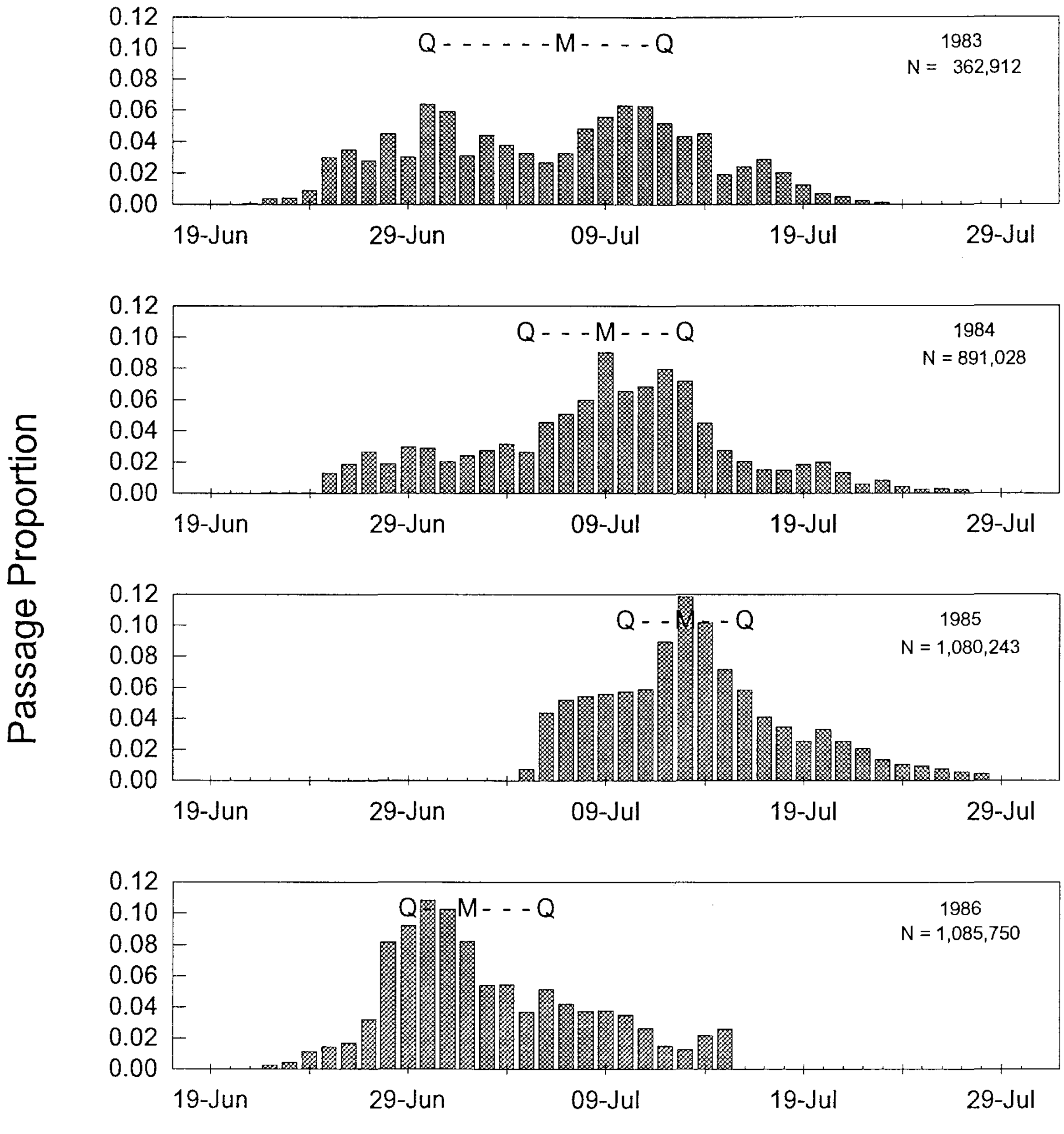

Figure 5. (page 2 of 4).

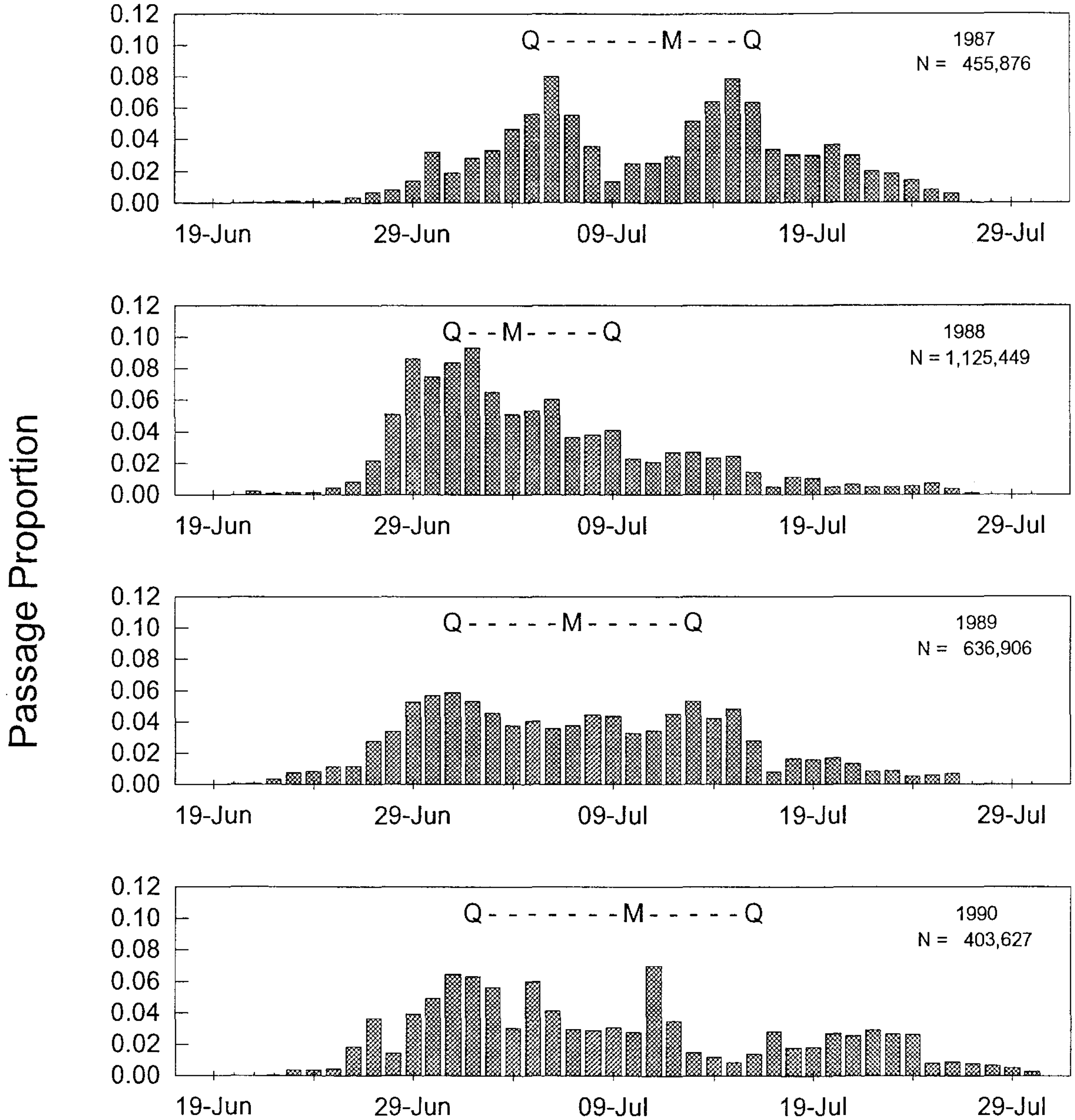

Figure 5. (page 3 of 4).

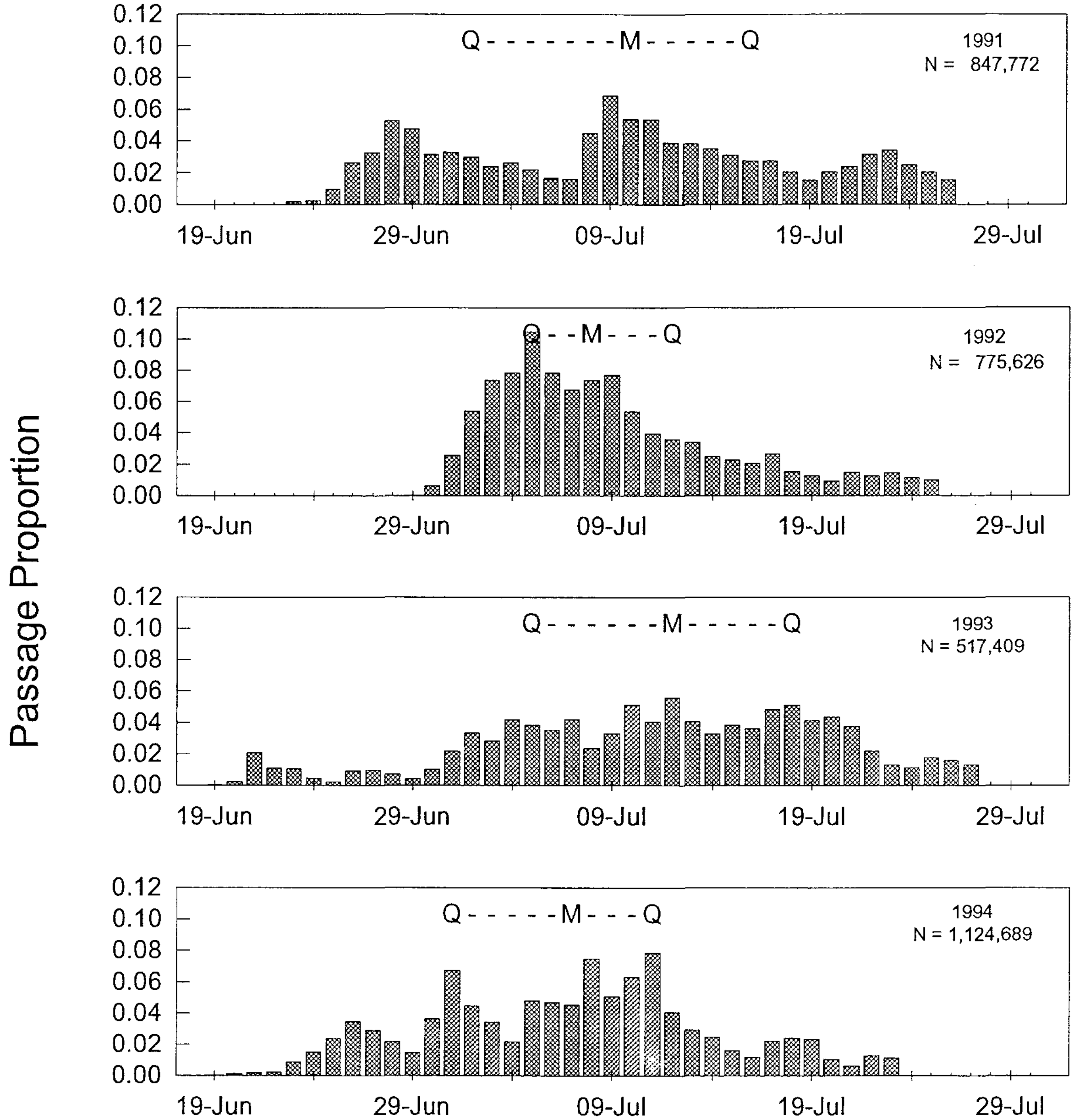

Figure 5. (page 4 of 4).

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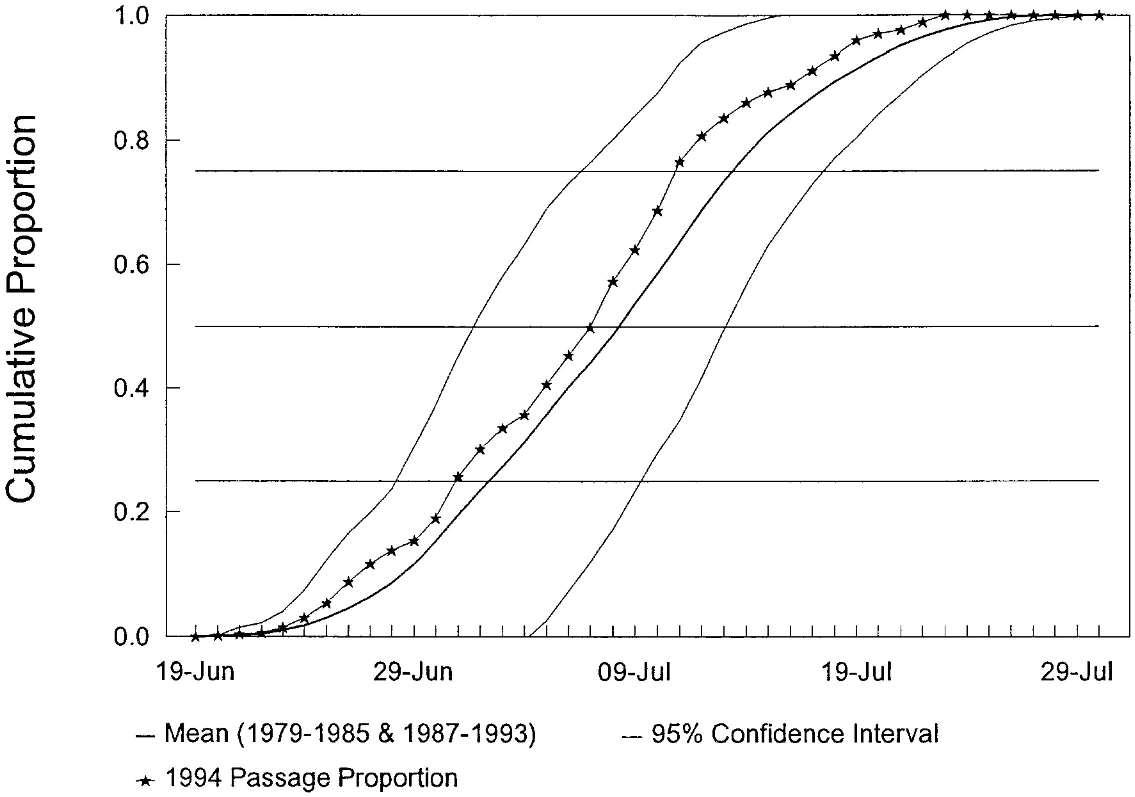


Figure 6. Mean (1979-1985 & 1987-1993) and the 1994 run timing curves for Anvik River summer chum salmon. Horizontal lines indicate quartile proportions.

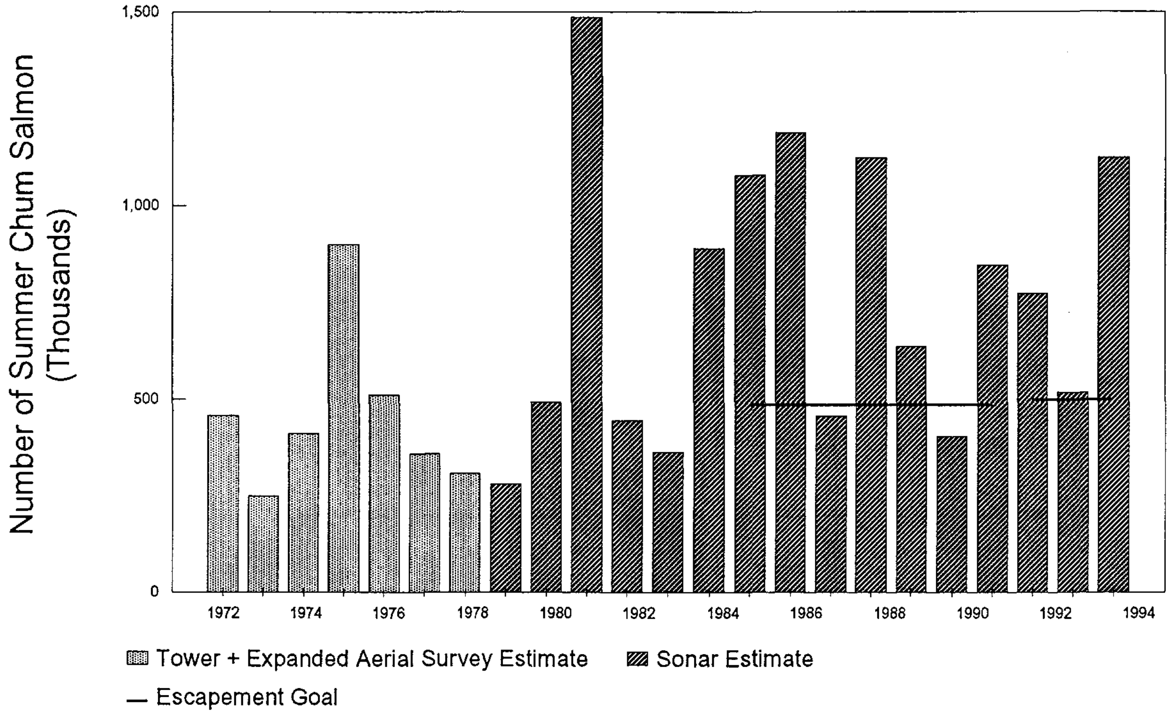


Figure 7. Anvik River summer chum salmon escapement estimated by combined tower and expanded aerial survey count, 1972-1978, and by side-scanning sonar, 1979-1994. Sonar count escapement goal of 487,000 salmon, effective from 1985 to 1991, and the present, minimum escapement goal of 500,000 salmon are indicated by the horizontal lines.

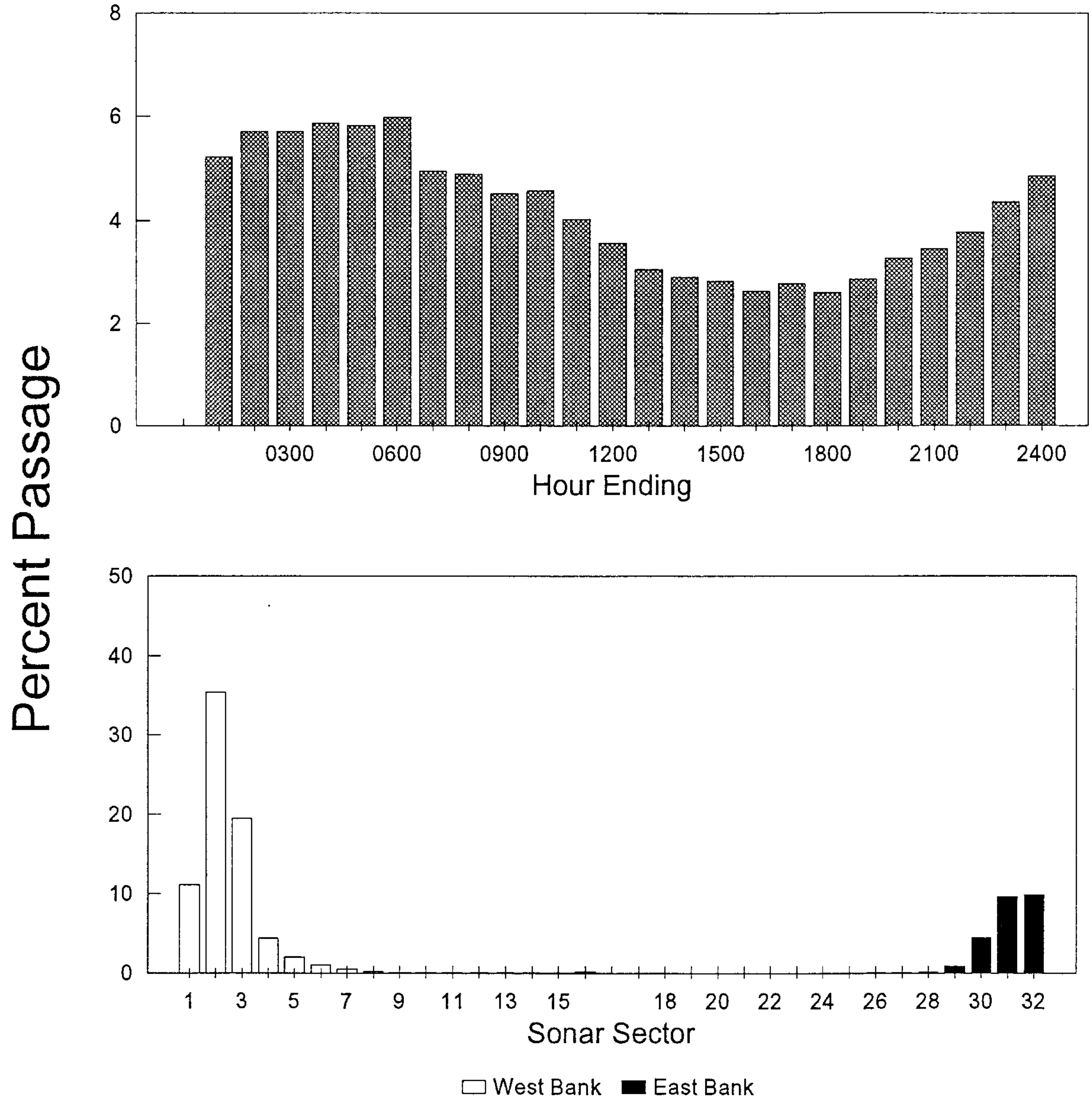


Figure 8. Estimated percent of corrected sonar counts in relation to hour of the day (above) and sonar sector (below), Anvik River, 1994. Note that only days with full 24-hour counts were used. Percent of counts attributed to summer chum salmon was 79.7%.

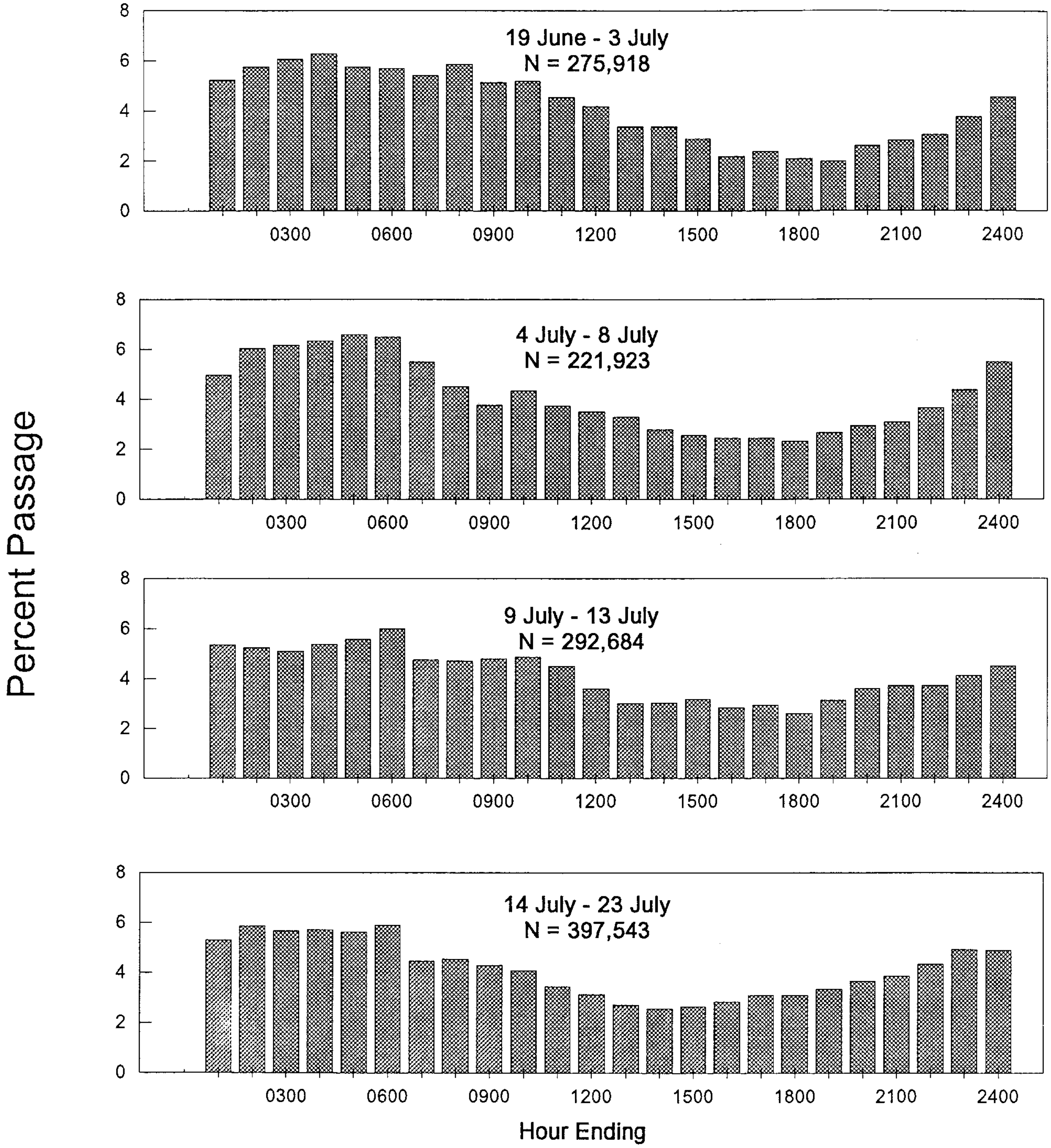


Figure 9. Estimated percent of corrected sonar counts by sampling stratum and hour of the day, Anvik River, 1994. Note that only days with full 24-hour counts were used. Percent of corrected sonar counts attributed to summer chum salmon for the four consecutive strata were 99.9%, 99.6%, 97.2%, and 43.1%, respectively.

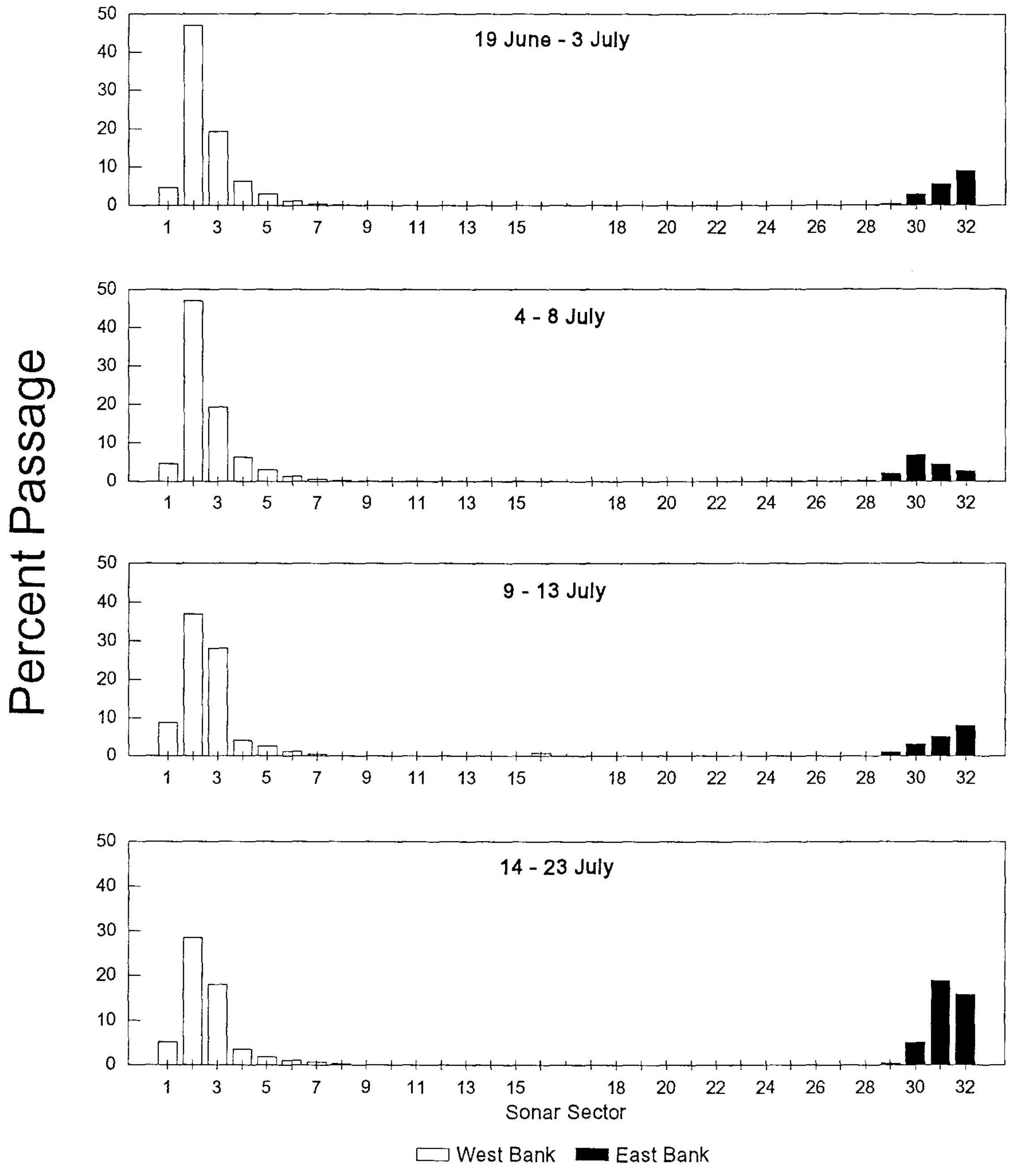


Figure 10. Estimated percent of corrected sonar counts by sampling stratum and sonar sector, Anvik River 1994. Note that only days with full 24-hour counts were used. Percent of corrected sonar counts attributed to summer chum salmon for the four consecutive strata were 99.9%, 99.6%, 97.2%, and 43.1%, respectively.

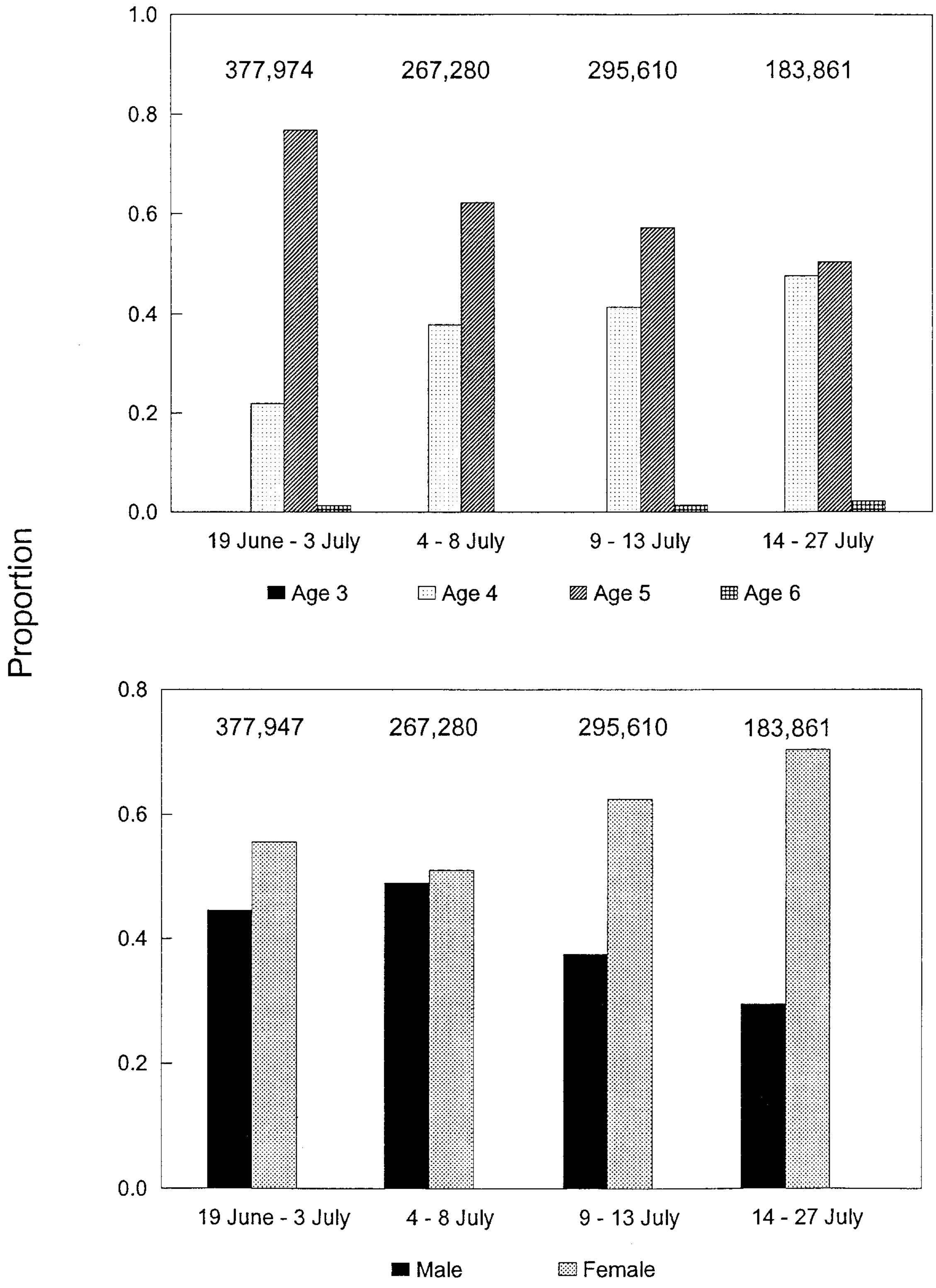


Figure 11. Age and sex compositon of sampled Anvik River summer chum salmon by sampling stratum, 1994. Numbers above bars indicate estimated passage during that stratum.

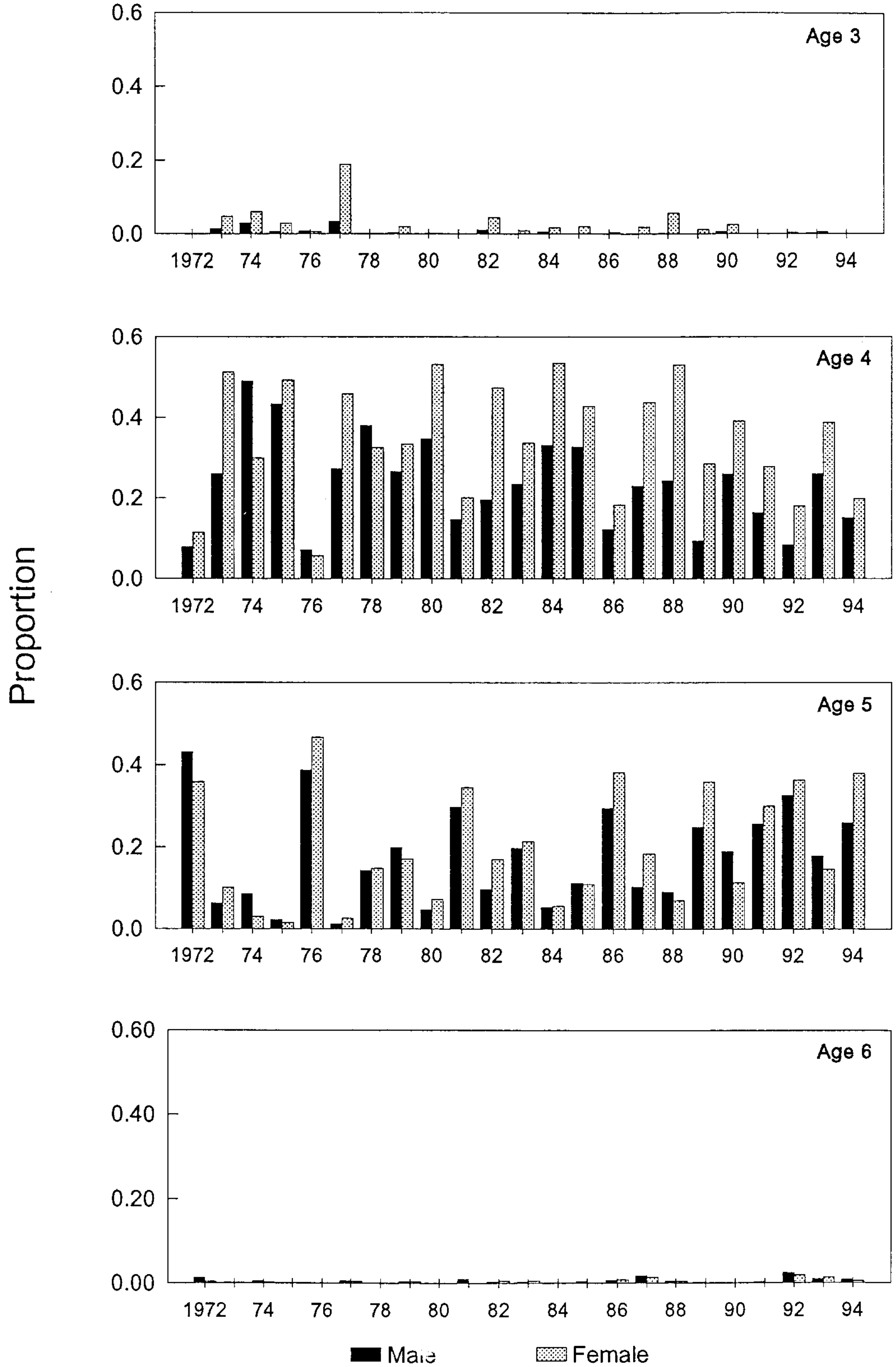
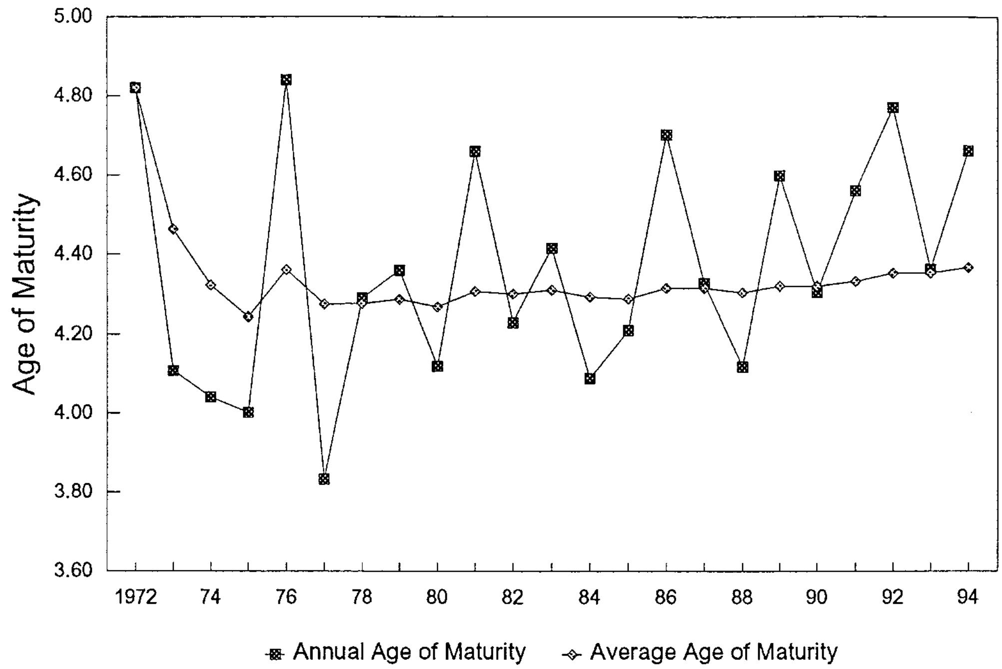


Figure 12. Estimated age and sex compostion of the Anvik River summer chum salmon escapement, 1972-1994.



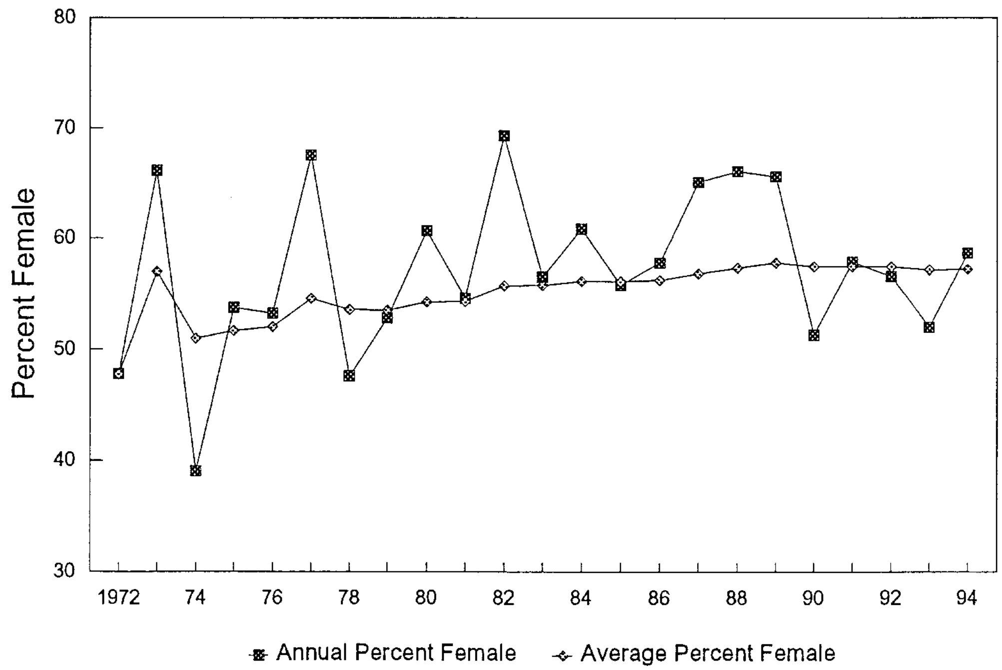


Figure 13. Annual and running average of the age of maturity (top) and percent female (bottom)of the summer chum salmon escapement to the Anvik River, 1972 - 1994.

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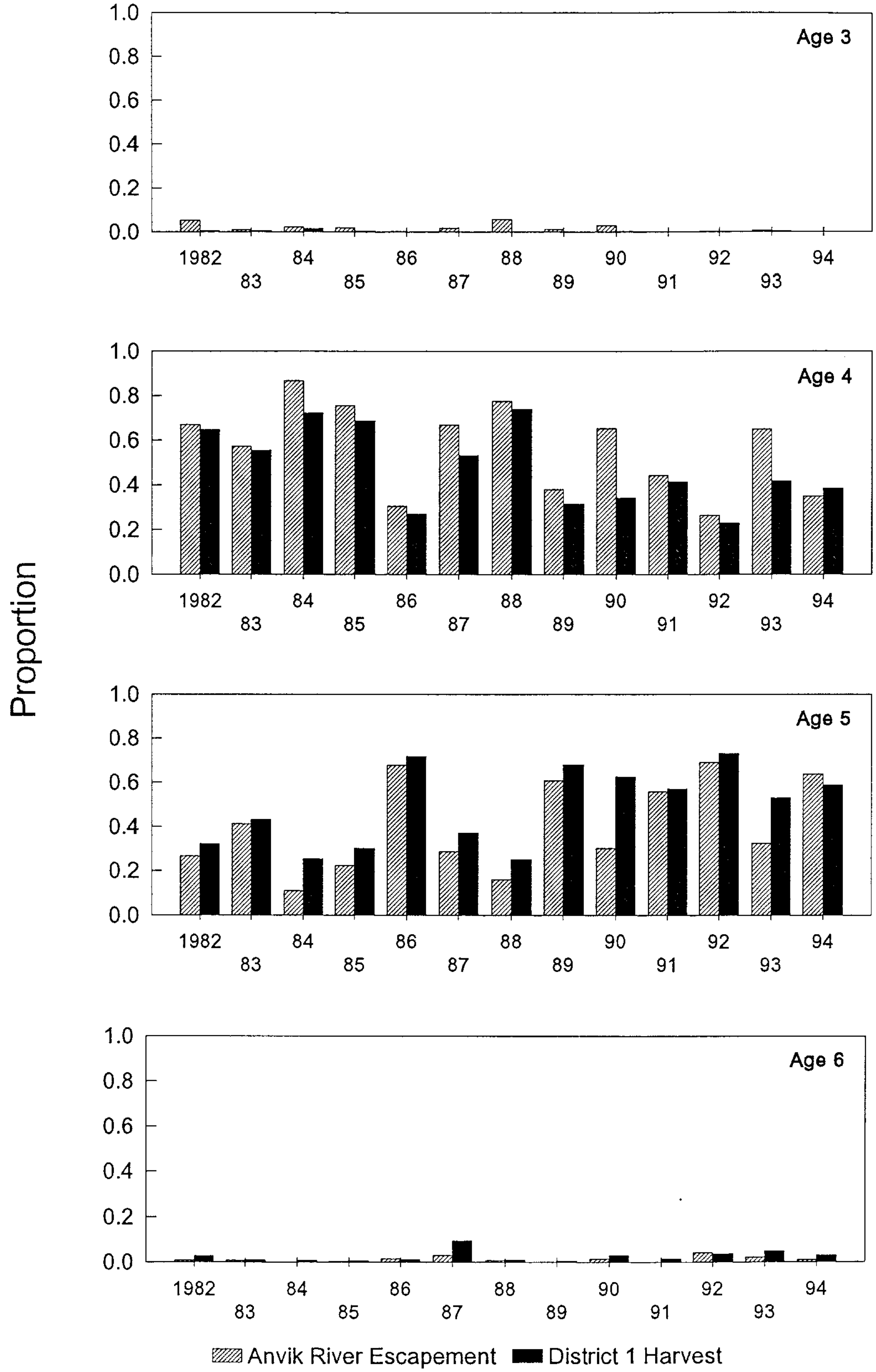

Figure 14. Estimated age compostion of the Anvik River summer chum salmon escapement and District 1 commercial harvest, 1982-1994.

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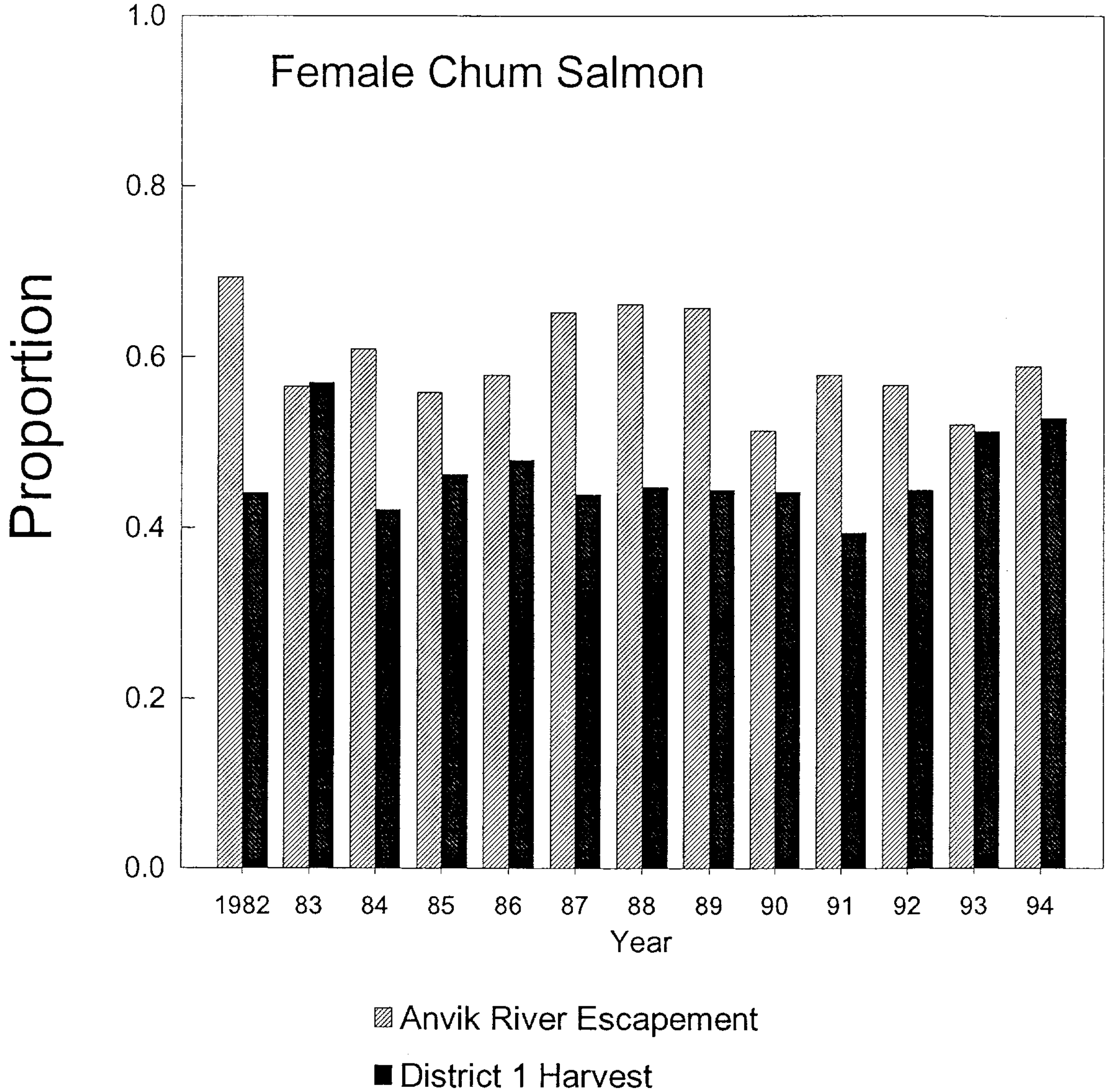

Figure 15. Estimated propnriton of female summer chum salmon in the Anvik River escapement and the District 1 commercial harvest, 1982-1994.

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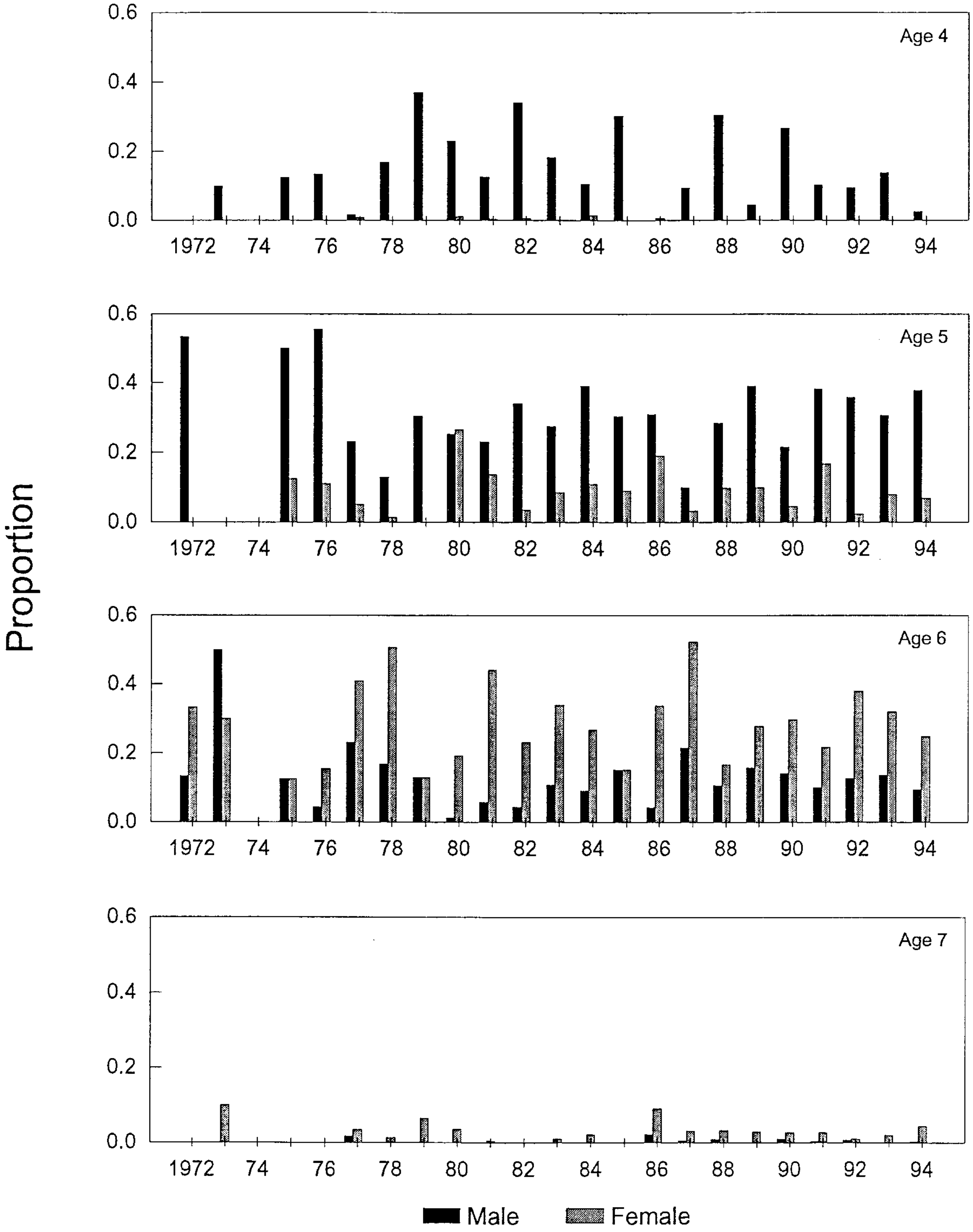

Figure 16. Estimated age and sex compostion of the Anvik River chinook salmon escapement, 1972-1994.

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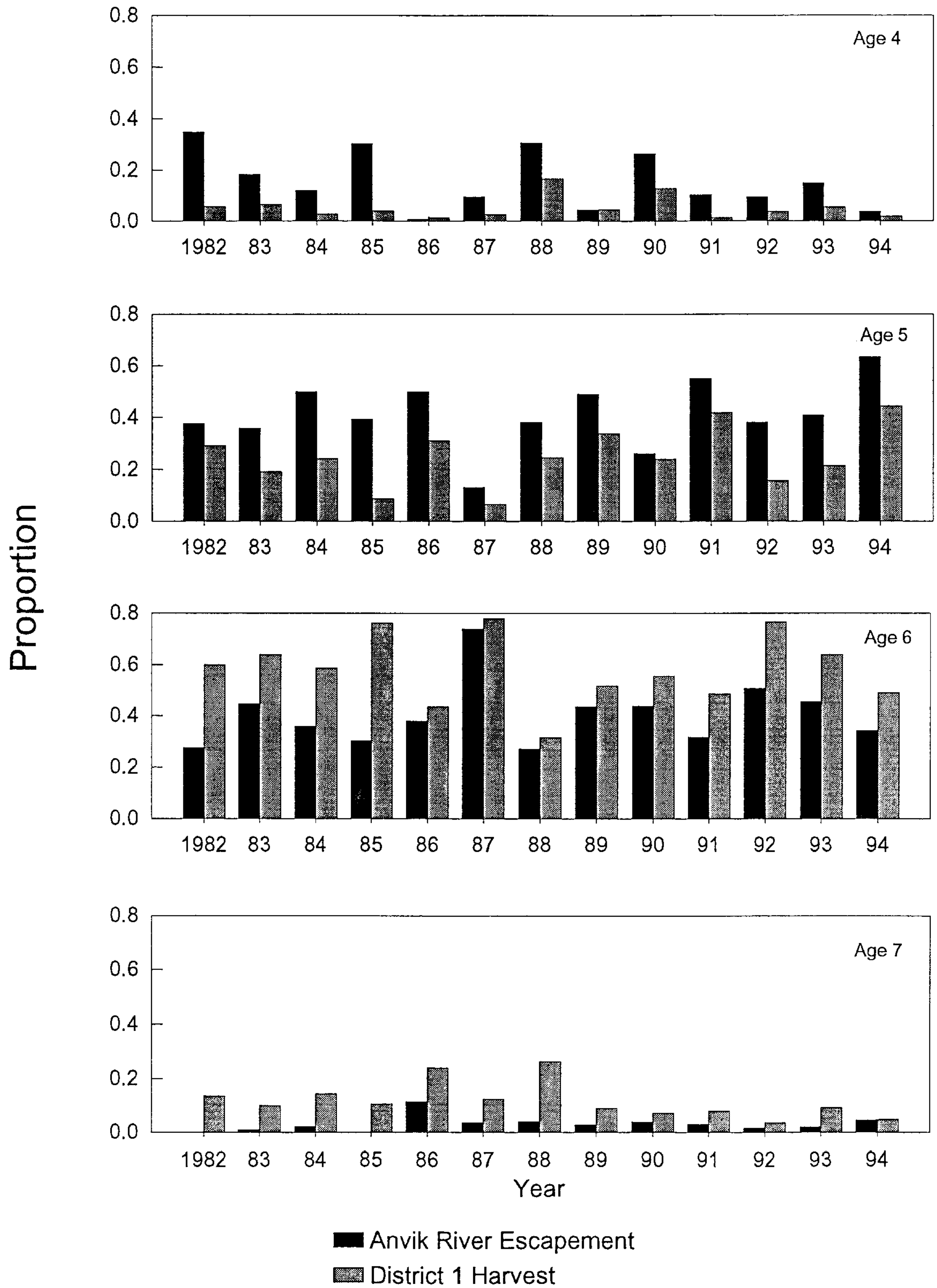

Figure 17. Estimated age composition of the Anvik River chinook salmon escapement and the District 1 commercial harvest, Yukon River, 1982-1994.

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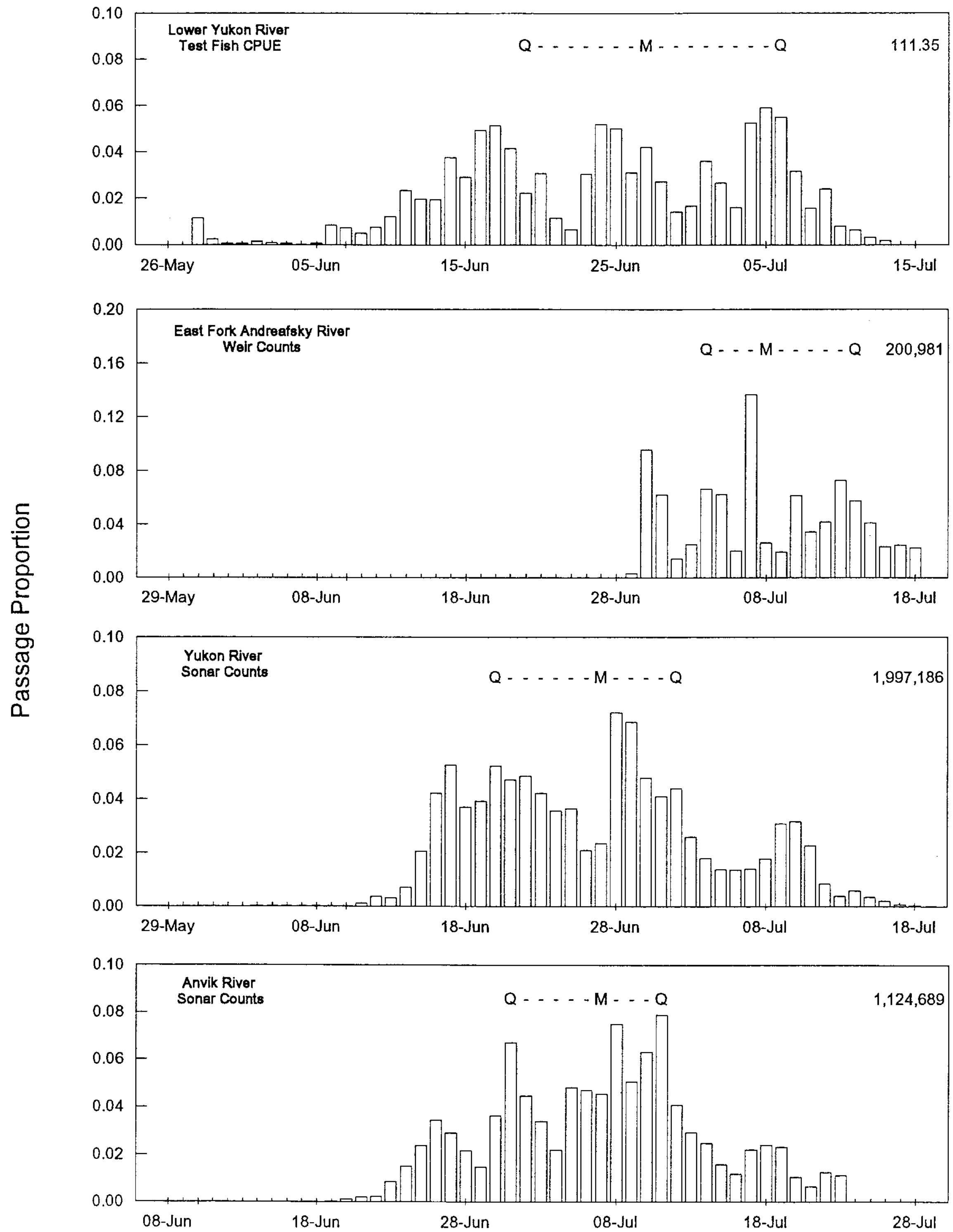

Figure 18. Run timing of the 1994 Yukon River summer chum salmon run as indicated by daily passage proportions of Lower Yukon Test fish CPUE, East Fork Andreafsky River weir counts, and Yukon River and Anvik River sonar passage estimates. First and third quartiles are indicated by the "Q"s, while the median day of passage is indicated by the "M". Note that the East Fork Andreafsky weir count and Yukon River and Anvik River sonar graph are time lagged by 3, 3, and 13 days, respectively, from the Lower Yukon test fish graph.

APPENDIX

Appendix A. West bank Anvik River corrected sonar counts by hour and date, 19 June - 23 July, 1994.

Hour Ending	19-June [a]	20-Jun	21-Jun	22-Jun	23-Jun [b]	24-Jun [c]	25-Jun [d]	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun [f]	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul [g]	07-Jul
0100		45	91	89			1,198	1,989	1,232	905	411		2,638	2,693	1,312	421	2,601		3,085
0200		71	99	99				2,149	1,524	1,095	806		2,740	2,992	1,522	1,442	2,532		4,000
0300		93	170	88				2,080	1,654	1,227	1,105		2,657	2,962	1,645	1,716	2,898		3,144
0400		49	140	138				1,713	1,804	1,129	1,254		2,388	2,801	2,329	1,691	3,112		3,099
0500		62	156	128				1,778	1,503	1,001	818		2,628	2,492	2,335	1,565	3,286		3,579
0600		77	172	93				1,542	1,552	1,114	679		2,743	2,565	1,954	1,528	3,258		3,528
0700		56	112	87				1,138	1,410	1,523	829		2,444	2,168	2,027	1,380	2,250		2,784
0800		32	171	73				1,974	1,623	1,630	511		3,028	1,941	2,005	880	2,052		1,920
0900		58	70	69			548	2,163	1,795	1,355	360		2,466	1,895	1,497	586	2,129		1,502
1000		82	97	70		284	1,645	2,248	1,729	1,576	344		2,330	1,697	1,503	427	1,969		2,705
1100		69	86	41		827	1,859	2,283	1,784	1,128	253	1,827	1,835	1,418	1,285	340	1,913		2,456
1200		29	133	28		895	1,503	2,144	1,849	1,310	220	1,658	1,714	1,185	1,099	322	2,056		1,725
1300		42	74	45		691	1,212	1,625	1,645	1,124	232	1,332	1,625	1,014	840	241	2,264		474
1400		23	40	60		535	1,005	1,764	1,723	1,098	227	1,086	1,552	1,029	792	178	2,228		504
1500		53	89	74		1,018	698	1,577	1,076	1,063	295	1,018	1,333	946	700	213	1,327		487
1600		77	61	102		719	639	1,255	527	768	290	1,110	985	807	584	190	1,333		431
1700		31	37	116		588	375	991	1,297	653	368	1,296	949	767	520	158	1,055		407
1800		31	46	117		513	467	765	836	544	376	1,063	1,000	666	569	275	833		497
1900		61	73	119		456	608	606	727	434	419	1,056	853	683	480	491	1,012		861
2000	27	50	83	105		403	781	674	869	413	777	1,052	1,406	782	689	606	1,022		1,079
2100	79	37	76	200		364	1,000	614	772	370	786	1,261	1,761	859	668	675	1,206		1,110
2200	44	74	42	171		600	1,194	850	716	389	972	1,473	1,822	816	704	751	1,612		1,518
2300	24	76	103	207		783	1,305	1,299	598	373	1,055	1,415	2,358	1,134	1,030	1,131	1,684		1,942
2400	105	94	59	80		943	1,312	1,343	825	491	1,885	1,680	2,573	1,455	1,354	2,039	1,777		2,380
Total	279	1,372	2,280	2,399	9,297	16,195	25,377	36,564	31,070	22,713	15,272	37,059	47,828	37,767	29,443	19,246	47,409	46,313	45,217

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Appendix A. (p 2 of 2).

Hour Ending	08-Jul	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul
0100	3,203	3,147	1,416	4,719	1,864	2,043	1,665	919	978	1,234	1,816	2,188	1,736	358	900	1,141
0200	4,086	3,082	1,442	4,914	1,747	1,771	1,725	1,351	921	1,565	2,638	2,914	1,865	736	1,368	1,441
0300	4,641	3,000	1,559	4,581	1,819	1,741	1,735	1,159	957	1,927	2,384	2,544	1,729	858	1,230	1,616
0400	4,555	3,038	1,693	4,640	1,943	1,798	1,560	963	1,178	2,014	2,626	2,369	1,999	731	1,286	1,488
0500	4,779	3,152	1,686	4,999	2,132	1,877	1,690	800	1,078	2,527	2,442	2,470	1,938	687	1,128	1,314
0600	4,469	3,096	2,354	5,193	2,023	1,432	1,563	993	1,373	1,993	2,486	2,152	1,488	624	1,307	1,463
0700	3,878	2,893	1,562	3,597	2,010	796	1,543	557	584	1,323	1,472	1,199	438	536	1,228	1,270
0800	3,644	2,765	1,257	3,368	2,352	1,598	1,192	345	648	1,405	1,329	1,261	380	592	1,288	1,410
0900	2,551	2,495	1,304	3,576	2,447	1,510	826	280	548	914	1,053	1,060	344	638	1,599	1,425
1000	3,188	2,741	1,610	3,965	1,690	1,313	802	460	716	904	598	919	424	642	1,889	1,310
1100	2,297	2,795	1,176	4,089	1,551	863	715	629	612	686	571	541	319	496	800	1,149
1200	2,364	2,396	716	3,315	1,519	421	648	680	466	573	588	544	361	442	852	983
1300	3,257	1,676	1,303	2,528	935	523	524	731	380	407	382	522	408	339	421	657
1400	2,346	1,472	1,248	2,388	1,220	649	641	502	464	442	460	524	408	521	862	935
1500	2,597	1,416	1,369	2,751	1,318	560	753	520	331	496	568	383	416	572	797	793
1600	2,439	694	1,423	2,377	1,468	582	602	500	349	755	661	612	392	396	971	898
1700	2,733	695	1,765	2,409	1,556	556	656	588	216	729	592	873	390	633	872	998
1800	2,361	483	1,631	2,180	1,101	401	765	500	226	652	693	782	347	513	1,142	866
1900	2,015	224	3,410	1,805	1,071	575	847	513	123	667	920	1,084	898	422	1,026	942
2000	1,872	349	4,739	1,899	1,130	832	687	529	200	938	778	1,067	817	603	1,035	1,200
2100	2,074	479	4,738	1,787	1,159	1,079	793	514	168	834	1,172	1,394	923	641	1,182	1,289
2200	2,179	388	4,800	1,709	905	1,111	527	562	185	1,214	1,311	1,698	924	1,055	1,483	1,228
2300	2,662	774	4,686	1,608	1,734	1,516	865	1,068	511	1,501	1,472	1,649	920	956	1,861	1,521
2400	3,336	1,261	5,092	1,872	1,553	1,733	853	1,017	607	2,041	1,537	1,144	746	1,132	1,495	1,268
Total	73,526	44,511	53,979	76,269	38,247	27,280	24,177	16,680	13,819	27,741	30,549	31,893	20,610	15,123	28,022	28,605

[a] Counting initiated on 19 June at 1900 hours
[b] Counts unavailable because of flood conditions. Daily passage estimated as mean number of daily adjusted counts on 22 June and estimated daily counts on 24 June.
[c] Counts unavailable for the hours ending 0100 - 0900. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 22 and 26 June.
[d] Counts unavailable for the hours ending 0200 - 0800. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 22 and 26 June.
[f] Counts unavailable for the hours ending 0100 - 1000. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 29 June and 1 July.
[g] Counts unavailable because data were lost. Daily passage estimated as mean number of daily adjusted counts on 5 and 7 July.

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Appendix B. East bank Anvik River corrected sonar counts by hour and date, 19 June - 23 July, 1994.

Hour Ending	19-June [a]	20-Jun	21-Jun	22-Jun [b]	23-Jun [c]	24-Jun [c]	25-Jun [c]	26-Jun [c]	27-Jun [c]	28-Jun [c]	29-Jun [c]	30-Jun [d]	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul
01:00		0	0	2									1,040	1,058	878	382	237	270	411
02:00		1	1	1									1,441	918	374	291	129	270	292
03:00		1	4	0									1,853	594	605	226	164	265	457
04:00		3	1	3									2,326	718	503	186	188	340	611
05:00		3	3	0									1,712	687	530	226	183	328	453
06:00		5	3	0									2,017	581	572	237	311	343	423
07:00		2	0	0									1,940	636	527	376	429	612	307
08:00		4	0	5									1,982	783	366	322	254	428	289
09:00		1	0	7									1,558	490	410	395	431	262	175
10:00		0	2	1									1,557	660	400	296	342	360	89
11:00		0	8	0									1,640	418	304	236	359	152	148
12:00		0	1	3									1,097	357	302	196	490	191	87
13:00		0	5									623	649	206	140	158	408	160	82
14:00		0	0									592	491	189	268	86	435	124	47
15:00		0	1									754	351	283	127	107	272	146	88
16:00		0	6									674	310	150	104	88	289	181	68
17:00	0	0	0									776	314	273	241	132	245	142	96
18:00	0	0	0									987	392	275	142	155	165	126	223
19:00	0	0	1									1,873	587	205	205	177	207	138	198
20:00	0	0	0									1,582	709	423	234	241	189	267	256
21:00	0	0	0									1,358	843	486	306	171	210	218	329
22:00	0	0	0									1,500	826	573	429	205	280	362	366
23:00	0	0	0									1,572	1,025	735	412	194	375	395	407
24:00	0	0	0									1,543	1,094	823	500	332	241	462	650
Total	0	20	36	90	397	790	1,412	2,315	2,234	1,850	1,407	3,851	27,754	12,521	8,879	5,415	6,833	6,542	6,552

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Appendix B. (page 2 of 2).

Hour Ending	08-Jul	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul [c]	14-Jul [c]	15-Jul [c]	16-Jul [f]	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul
0100	410	981	572	634	221					1,086	713	1,200	1,446	428	1,199	2,063
0200	356	931	565	477	360					463	1,157	1,003	1,084	521	779	1,773
0300	212	638	652	568	307					628	774	1,102	834	558	738	1,716
0400	272	889	764	691	219					861	714	1,005	1,098	481	794	1,521
0500	258	952	800	498	214					713	952	1,263	1,151	344	652	1,196
0600	291	1,158	1,177	571	508					963	1,346	1,755	1,561	299	761	1,328
0700	210	711	933	654	734					773	1,943	1,234	950	313	973	1,424
0800	234	711	709	664	328					941	1,781	1,253	995	296	718	2,232
0900	333	422	879	1,036	325					987	1,835	1,455	991	302	890	1,947
1000	274	422	973	857	620					1,144	1,458	1,562	849	276	889	1,357
1100	394	490	924	778	461				443	840	1,154	1,723	1,184	236	928	1,118
1200	316	318	744	788	294				362	541	881	1,410	1,575	295	619	974
1300	257	318	656	542	284				288	529	653	1,347	1,226	248	600	1,449
1400	227	396	526	505	431				156	380	775	1,046	763	196	618	635
1500	443	600	631	332	300				201	439	806	934	1,106	365	472	777
1600	427	449	561	305	457				215	676	932	1,243	919	236	568	599
1700	477	293	735	281	319				133	561	1,383	1,188	935	330	693	618
1800	525	268	873	335	324				131	743	1,314	1,183	895	351	728	612
1900	819	235	1,143	320	346				277	735	1,301	1,140	613	359	1,053	658
2000	954	163	693	295	384				319	771	1,367	1,324	718	350	1,475	663
2100	832	305	631	291	380				482	1,136	1,325	1,094	494	407	1,361	643
2200	828	353	729	311	581				763	1,123	1,462	970	319	403	1,936	867
2300	882	397	618	368	349				795	1,199	1,063	1,050	416	755	1,817	925
2400	952	607	492	215	349				825	1,164	1,113	1,209	341	530	2,155	1,180
Total	11,183	13,007	17,980	12,316	9,095	11,436	11,150	8,451	9,717	19,396	28,202	29,693	22,463	8,879	23,416	28,275

[a] Counting initiated on 19 June at 1600 hours.

[b] Counting suspended at 1130 hours. Total daily passage was estimated based on a flexible equation fitted to east bank passage proportion data for all days with 24 hour counts.

[c] Counts unavailable because of flood conditions. Total daily east bank passage was estimated based on a flexible equation which was fitted to the east bank passage proportion data for all days with 24 hour counts.

[d] Counts unavailable for the hours ending 0100 - 1200. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 1 and 2 July.

[f] Counts unavailable for the hours ending 0100 - 1000. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 17 and 18 July.

Appendix C. West bank Anvik River corrected sonar counts by sector, 19 June - 23 July, 19 [a]

West Bank Sector	19-June [b]	20-Jun	21-Jun	22-Jun	23-Jun [c]	24-Jun [d]	25-Jun [f]	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun [g]	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul [h]	07-Jul
1	31	136	223	365		2,468	6,953	2,742	1,557	2,764	2,287	914	1,396	757	256	130	2,928		5,955
2	119	470	1,147	1,169		5,548	8,039	21,149	17,338	6,019	9,542	13,525	36,643	24,595	11,443	9,829	21,668		20,065
3	61	268	510	443		983	1,669	10,064	8,879	5,082	2,521	2,570	7,872	8,377	9,038	6,659	13,789		16,097
4	50	215	227	125		205	309	1,421	1,290	2,862	345	825	1,555	2,886	6,177	1,218	2,333		1,274
5	14	125	77	40		112	145	656	997	2,758	236	292	304	808	1,878	918	2,895		598
6	2	62	50	91		99	77	178	424	1,613	130	57	45	289	551	326	1,327		497
7	1	15	7	45		88	77	96	302	790	78	33	12	45	73	68	543		226
8	1	7	7	13		16	27	54	154	338	40	21	1	7	20	13	112		57
9	0	2	2	5		10	5	8	28	145	7	0	0	2	2	5	20		64
10	0	1	6	11		22	23	29	28	157	18	0	0	2	1	8	28		96
11	0	6	4	8		14	3	9	7	61	10	0	0	0	0	6	22		34
12	0	4	4	13		6	1	4	11	25	9	8	0	0	1	10	17		33
13	0	5	3	4		9	4	8	13	29	7	17	0	0	1	22	21		53
14	0	0	8	8		6	6	0	21	19	5	19	0	0	0	5	27		67
15	0	2	3	1		22	5	2	9	19	30	23	0	0	0	5	34		35
16	0	49	1	58		13	8	145	11	33	10	21	0	0	0	23	1,645		66
Total	279	1,367	2,279	2,399	9,297	16,195	25,377	36,565	31,069	22,714	15,275	37,059	47,828	37,768	29,441	19,245	47,409	46,313	45,217

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Appendix C. (p 2 of 2).

West Bank Sector	08-Jul	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul
1	10,309	8,256	20,491	25,010	14,698	11,038	6,801	2,443	1,571	2,567	2,005	827	778	1,015	1,430	1,221
2	30,415	18,295	22,296	31,546	12,549	11,435	11,291	9,451	9,360	16,805	16,896	13,660	8,702	5,982	11,156	9,486
3	25,835	9,068	6,934	18,292	8,258	2,514	3,777	3,330	2,149	6,260	8,358	11,610	7,090	4,921	10,883	12,934
4	4,409	4,503	2,308	557	2,524	1,807	1,357	831	358	946	1,399	2,773	1,599	1,080	1,882	2,063
5	1,327	1,748	790	196	94	132	300	211	186	593	968	1,759	1,042	568	906	1,096
6	731	1,373	514	63	23	45	142	113	116	360	505	874	620	480	489	593
7	210	598	269	0	46	50	99	88	62	175	225	325	329	389	457	502
8	59	147	79	0	0	51	99	47	10	34	43	54	110	221	318	328
9	73	184	88	1	0	24	47	21	0	0	0	0	23	53	69	49
10	56	125	71	0	0	47	89	36	2	1	2	4	89	129	94	63
11	24	41	19	7	2	47	55	18	0	1	2	1	28	72	118	46
12	15	36	16	36	9	33	37	11	0	0	0	0	19	40	33	25
13	14	36	30	70	1	28	26	13	1	0	5	0	25	26	32	30
14	17	38	24	90	4	15	22	3	0	0	7	2	21	36	32	25
15	21	25	21	178	9	6	22	20	0	1	23	1	38	80	56	47
16	16	39	29	221	30	10	12	42	4	0	110	2	97	33	66	98
Total	73,531	44,512	53,979	76,267	38,247	27,282	24,176	16,678	13,819	27,743	30,548	31,892	20,610	15,125	28,021	28,606

[a] Daily sector counts may deviate from daily counts because of rounding errors.
[b] Counting initiated on 19 June at 1900 hours
[c] Counts unavailable because of flood conditions. Daily passage estimated as mean number of daily adjusted counts on 22 June and estimated daily counts on 24 June.
[d] Counts unavailable for the hours ending 0100 - 0900. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 22 and 26 June. See Appendix B .
[f] Counts unavailable for the hours ending 0200 - 0800. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 22 and 26 June. See Appendix B.
[g] Counts unavailable for the hours ending 0100 - 1000. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 29 June and 1 July. See Appendix B.
[h] Counts unavailable because data were lost. Daily passage estimated as mean number of daily adjusted counts on 5 and 7 July.

Appendix D. East bank Anvik River corrected sonar counts by sector, 19 June - 23 July, 19 [a]

East Bank Sector	19-June [b]	20-Jun	21-Jun	22-Jun [c]	23-Jun [d]	24-Jun [d]	25-Jun [d]	26-Jun [d]	27-Jun [d]	28-Jun [d]	29-Jun [d]	30-Jun [f]	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul
17	0	1	18	0								0	0	0	4	0	0	0	0
18	0	0	6	0								0	0	0	4	0	0	0	0
19	0	0	0	0								0	0	0	0	0	0	0	0
20	0	0	1	0								0	0	0	0	0	0	0	0
21	0	0	0	0								0	0	0	0	0	0	0	0
22	0	0	0	0								0	0	0	0	0	1	0	1
23	0	0	0	0								0	0	0	1	1	0	0	0
24	0	0	0	0								0	1	0	5	5	5	0	4
25	0	0	0	0								0	1	5	4	6	12	3	3
26	0	0	1	0								2	4	14	5	22	24	14	16
27	0	0	0	0								2	5	15	13	38	35	21	28
28	0	0	0	2								2	19	57	61	101	96	65	93
29	0	0	0	0								159	218	385	419	637	793	403	536
30	0	1	3	1								2,301	2,763	3,033	2,345	1,956	2,625	2,578	2,615
31	0	18	3	5								3,958	8,094	3,909	2,940	1,692	2,044	1,912	1,736
32	0	0	4	14								7,413	16,647	5,105	3,077	959	1,200	1,544	1,521
Total	0	20	36	90	397	790	1,412	2,315	2,234	1,850	1,407	3,851	27,752	12,523	8,878	5,417	6,835	6,540	6,553

continued

Appendix D. (p 2 of 2).

East Bank Sector	08-Jul	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul [d]	14-Jul [d]	15-Jul [d]	16-Jul "	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul
17	0	0	0	0	0				0	0	0	0	0	0	0	0
18	0	0	0	0	0				0	0	0	0	0	0	0	0
19	0	0	0	0	0				1	0	0	0	0	0	0	0
20	0	0	0	0	0				0	0	0	0	0	0	0	0
21	0	0	1	0	0				0	0	0	0	0	0	0	0
22	4	2	3	3	6				4	0	0	1	1	0	0	3
23	14	18	22	22	26				12	7	3	7	7	1	0	6
24	31	42	35	25	21				6	12	5	8	12	9	10	14
25	22	13	7	3	2				2	16	18	3	9	12	11	32
26	72	82	32	13	10				8	24	16	24	35	17	27	61
27	66	78	33	37	14				13	15	18	11	24	21	16	35
28	198	205	47	25	27				81	30	37	39	55	39	55	124
29	2,252	1,758	763	385	413				345	204	208	292	215	261	318	500
30	5,373	3,770	2,765	1,472	1,496				720	2,123	2,832	3,956	1,871	1,087	2,305	5,916
31	2,397	4,874	4,862	3,044	2,352				2,198	8,837	12,868	14,082	10,756	4,016	11,550	12,649
32	753	2,168	9,408	7,288	4,730				1,999	8,129	12,197	11,270	9,478	3,417	9,125	8,935
Total	11,182	13,010	17,978	12,317	9,097	11,436	11,150	8,451	9,717	19,397	28,202	29,693	22,463	8,880	23,417	28,275

[a] Daily sector counts may slightly deviate from daily hourly counts because of rounding errors.
[b] Counting initiated on 19 June at 1600 hours.
[c] Counting suspended at 1130 hours. Total daily passage was estimated based on a curvilinear equation fitted to east bank passage proportion data for all days with 24-h counts.
[d] Counts unavailable because of flooding conditions. Total east bank passage was estimated based on a curvilinear equation which was fitted to the east bank passage proportion data for all day s with 24-h counts.
[f] Counts unavailable for the hours ending 0100-1200. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 1 and 2 July.
Counts unavailable for the hours ending 0100-1000. Daily passage was estimated by dividing the sum of the available counts by the proportion of the daily counts for the same period on 17 and 18 July.

Appendix E. Anvik River salmon beach seine catch by species, sex, and date, and number of chum salmon sampled for age, sex, size information, by sex and date, 1994.

		Chum Salmon									Pink Salmon			Non-salmon Species			
	Number	Number Captured			Number Sampled			Number Aged			Number Captured			Number Captured			
Date	of Sets	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	grayling	whitefish	pike	sheefish
19-Jun																	
20-Jun																	
21-Jun																	
22-Jun																	
23-Jun																	
24-Jun																	
25-Jun																	
26-Jun																	
27-Jun	4	27	16	43	24	14	38	19	14	33	0	0	0	21	1	0	1
28-Jun	3	25	18	43	25	18	43	23	16	39	0	0	0	2	1	0	0
29-Jun																	
30-Jun	3	21	46	67	21	46	67	18	43	61	0	0	0	1	1	0	0
01-Jul																	
02-Jul																	
03-Jul	1	64	91	155	5	10	15	5	8	13	0	0	0	0	0	0	0
04-Jul																	
05-Jul	1	38	18	56	38	18	56	27	16	43	0	0	0	1	0	0	0
06-Jul	1	66	81	147	18	22	40	14	19	33	0	0	0	0	0	0	0
07-Jul																	
08-Jul	1	67	79	146	30	36	66	26	33	59	0	0	0	0	0	0	0
09-Jul	2	26	31	57	26	31	57	24	26	50	1	0	1	2	0	0	0
10-Jul																	
11-Jul	2	15	23	38	15	23	38	11	19	30	2	1	3	4	0	0	0
12-Jul	1	46	91	137	21	44	65	15	43	58	2	0	2	1	0	0	0
13-Jul																	
14-Jul	1	16	28	44	16	28	44	13	26	39	1	1	2	6	0	0	0
15-Jul																	
16-Jul																	
17-Jul	1	17	36	53	17	36	53	13	31	44	5	5	10	2	0	0	0
18-Jul																	
19-Jul	1	18	18	36	18	18	36	14	16	30	8	4	12	3	2	0	0
20-Jul																	
21-Jul	1	48	154	202	7	23	30	7	21	28	5	6	11	1	0	2	0
22-Jul																	
23-Jul																	
24-Jul																	
25-Jul																	
26-Jul																	
27-Jul																	
Stratum Totals																	
19 June - 3 Jul	11	137	171	308	75	88	163	65	81	146	0	0	0	24	3	0	1
Percent		44.5	55.5		46.0	54.0		44.5	55.5								
4 June - 8 July	3	171	178	349	86	76	162	67	68	135	0	0	0	1	0	0	0
Percent		49.0	51.0		53.1	46.9		49.6	50.4								
9 June -13 July	5	87	145	232	62	98	160	50	88	138	5	1	6	7	0	0	0
Percent		37.5	62.5		38.8	61.3		36.2	63.8								
14 June -23 Jul	4	99	236	335	58	105	163	47	94	141	19	16	35	12	2	2	0
Percent		29.6	70.4		35.6	64.4		33.3	66.7								
Season Totals	23	494	730	1,224	281	367	648	229	331	560	24	17	41	44	5	2	1
Percent		40.4	59.6		43.4	56.6		40.9	59.1								

Appendix F. Age and sex composition of Anvik River summer chum salmon, 1972 - 1994.

	Number of Fish [a]															
	Total Sample			Number	Age 0.2			Age 0.3			Age 0.4			Age 0.5		
Year	Male	Female	Total	Aged	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	167	153	320	320	0	0	0	25	37	62	138	115	253	4	1	5
1973	265	518	783	783	11	37	48	204	401	605	49	79	128	1	1	2
1974	245	157	402	402	12	24	36	197	120	317	34	12	46	2	1	3
1975	270	314	584	584	4	17	21	253	288	541	13	9	22	0	0	0
1976	281	320	601	601	5	4	9	43	35	78	233	281	514	0	0	0
1977	191	398	589	589	20	111	131	161	270	431	7	15	22	3	2	5
1978	289	263	552	552	0	1	1	210	180	390	79	82	161	0	0	0
1979	273	306	579	579	2	12	14	154	193	347	115	99	214	2	2	4
1980	167	258	425	425	0	1	1	147	226	373	20	31	51	0	0	0
1981	151	182	333	333	0	0	0	49	67	116	99	115	214	3	0	3
1982	117	265	382	382	4	17	21	75	181	256	37	65	102	1	2	3
1983	183	238	421	421	0	4	4	99	142	241	83	90	173	1	2	3
1984	138	215	353	353	2	6	8	117	189	306	19	20	39	0	0	0
1985	233	294	527	527	0	11	11	172	225	397	59	58	117	2	0	2
1986	205	281	486	486	0	2	2	59	89	148	143	186	329	3	4	7
1987	190	355	545	545	0	10	10	125	238	363	56	100	156	9	7	16
1988	180	351	531	531	1	30	31	129	282	411	48	37	85	2	2	4
1989	199	389	588	588	0	9	9	55	179	234	143	201	344	1	0	1
1990	172	227	399	399	3	12	15	98	169	267	67	45	112	4	1	5
1991	239	313	552	552	0	0	0	96	153	249	141	160	301	2	0	2
1992	162	262	424	424	0	3	3	39	98	137	115	154	269	8	7	15
1993	325	335	660	546	1	3	4	140	201	341	106	81	187	6	8	14
1994	494	730	1,224	560	0	0	0	87	120	207	138	208	346	4	3	7

continued

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Year	Percent of Sample [b]														
	Total Sample			Age 0.2			Age 0.3			Age 0.4			Age 0.5		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	52.2	47.8	100.0	0.0	0.0	0.0	7.8	11.6	19.4	43.1	35.9	79.1	1.3	0.3	1.6
1973	33.8	66.2	100.0	1.4	4.7	6.1	26.1	51.2	77.3	6.3	10.1	16.3	0.1	0.1	0.3
1974	60.9	39.1	100.0	3.0	6.0	9.0	49.0	29.9	78.9	8.5	3.0	11.4	0.5	0.2	0.7
1975	46.2	53.8	100.0	0.7	2.9	3.6	43.3	49.3	92.6	2.2	1.5	3.8	0.0	0.0	0.0
1976	46.8	53.2	100.0	0.8	0.7	1.5	7.2	5.8	13.0	38.8	46.8	85.5	0.0	0.0	0.0
1977	32.4	67.6	100.0	3.4	18.8	22.2	27.3	45.8	73.2	1.2	2.5	3.7	0.5	0.3	0.8
1978	52.4	47.6	100.0	0.0	0.2	0.2	38.0	32.6	70.7	14.3	14.9	29.2	0.0	0.0	0.0
1979	47.2	52.8	100.0	0.3	2.1	2.4	26.6	33.3	59.9	19.9	17.1	37.0	0.3	0.3	0.7
1980	39.3	60.7	100.0	0.0	0.2	0.2	34.6	53.2	87.8	4.7	7.3	12.0	0.0	0.0	0.0
1981	45.3	54.7	100.0	0.0	0.0	0.0	14.7	20.1	34.8	29.7	34.5	64.3	0.9	0.0	0.9
1982	30.6	69.4	100.0	1.0	4.5	5.5	19.6	47.4	67.0	9.7	17.0	26.7	0.3	0.5	0.8
1983	43.5	56.5	100.0	0.0	1.0	1.0	23.5	33.7	57.2	19.7	21.4	41.1	0.2	0.5	0.7
1984	39.1	60.9	100.0	0.6	1.7	2.3	33.1	53.5	86.7	5.4	5.7	11.0	0.0	0.0	0.0
1985	44.2	55.8	100.0	0.0	2.1	2.1	32.6	42.7	75.3	11.2	11.0	22.2	0.4	0.0	0.4
1986	42.2	57.8	100.0	0.0	0.4	0.4	12.1	18.3	30.5	29.4	38.3	67.7	0.6	0.8	1.4
1987	34.9	65.1	100.0	0.0	1.8	1.8	22.9	43.7	66.6	10.3	18.3	28.6	1.7	1.3	2.9
1988	33.9	66.1	100.0	0.2	5.6	5.8	24.3	53.1	77.4	9.0	7.0	16.0	0.4	0.4	0.8
1989 [c]	34.4	65.6	100.0	0.0	1.2	1.2	9.4	28.5	37.9	24.8	35.9	60.7	0.1	0.0	0.1
1990 [c]	48.7	51.3	100.0	0.6	2.5	3.2	26.0	39.1	65.1	18.8	11.3	30.1	1.2	0.4	1.6
1991 [c]	42.1	57.9	100.0	0.0	0.0	0.0	16.4	27.8	44.2	25.6	30.1	55.6	0.2	0.0	0.2
1992 [c]	43.4	56.6	100.0	0.0	0.3	0.3	8.4	18.1	26.5	32.6	36.3	69.0	2.4	1.8	4.2
1993 [c,d]	48.0	52.0	100.0	0.1	0.5	0.6	26.1	38.8	64.8	17.8	14.6	32.4	0.9	1.3	2.2
1994 [c,d]	41.3	58.7	100.0	0.0	0.0	0.0	15.2	19.8	35.0	25.8	38.0	63.8	0.7	0.5	1.2

[a] Samples collected by carcass survey 1972-1981, by beach seine 1983-1992, and by both methods combined in 1982.
[b] Sample percentages not weighted by time period or escapement counts unless otherwise noted.
[c] Sample percentages weighted by time period and escapement counts.
[d] Sex compostion based on entire beach seine catch. Age compostion based on aged scales.

Appendix G. Age and sex composition of Anvik River chinook salmon escapement samples, 1972-1994.

	Number of Chinook Salmon [a]														
	Sample			Age 4 [c]			Age 5			Age 6			Age 7		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	10	5	15	0	0	0	8	0	8	2	5	7	0	0	0
1973	6	4	10	1	0	1	0	0	0	5	3	8	0	1	1
1974	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
1975	6	2	8	1	0	1	4	1	5	1	1	2	0	0	0
1976	33	12	45	6	0	6	25	5	30	2	7	9	0	0	0
1977	58	59	117	2	1	3	27	6	33	27	48	75	2	4	6
1978	36	41	77	13	0	13	10	1	11	13	39	52	0	1	1
1979	37	9	46	17	0	17	14	0	14	6	6	12	0	3	3
1980	41	42	83	19	1	20	21	22	43	1	16	17	0	3	3
1981	109	154	263	33	1	34	61	36	97	15	116	131	0	1	1
1982	100	38	138	47	1	48	47	5	52	6	32	38	0	0	0
1983	173	133	306	56 [b]	0	56	84	26	110	33	104	137	0	3	3
1984	162	114	276	29	4	33	108	30	138	25	74	99	0	6	6
1985	25	8	33	10	0	10	10	3	13	5	5	10	0	0	0
1986	53	89	142	0	1	1	44	27	71	6	48	54	3	13	16
1987	92	130	222	21	0	21	22	7	29	48	116	164	1	7	8
1988	173	73	246	75	0	75	70	24	94	26	41	67	2	8	10
1989	226	155	381	17 [b]	0	17	149	38	187	60	106	166	0	11	11
1990	252	148	400	106 [b]	0	106	86	18	104	56	119	175	4	11	15
1991	223	155	378	39	0	39	145	63	208	38	82	120	1	10	11
1992	185	130	315	30	0	30	113	7	120	40	120	160	2	3	5
1993	197	143	340	47	0	47	104	27	131	46	109	155	0	7	7
1994	280	190	470 [d]	12	0	12	178	32	210	44	117	161	1	21	22

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Appendix G. (page 2 of 2).

	Percent of Total Sample[c]																	
	Sample[a]			Age 4			Age 5			Age 6			Age 7					
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total			
1972	66.7	33.3	100.0	0.0	0.0	0.0	53.3	0.0	53.3	13.3	33.3	46.7	0.0	0.0	0.0			
1973	60.0	40.0	100.0	10.0	0.0	10.0	0.0	0.0	0.0	50.0	30.0	80.0	0.0	10.0	10.0			
1974	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-			
1975	75.0	25.0	100.0	12.5	0.0	12.5	50.0	12.5	62.5	12.5	12.5	25.0	0.0	0.0	0.0			
1976	73.3	26.7	100.0	13.3	0.0	13.3	55.6	11.1	66.7	4.4	15.6	20.0	0.0	0.0	0.0			
1977	49.6	50.4	100.0	1.7	0.9	2.6	23.1	5.1	28.2	23.1	41.0	64.1	1.7	3.4	5.1			
1978	46.8	53.2	100.0	16.9	0.0	16.9	13.0	1.3	14.3	16.9	50.6	67.5	0.0	1.3	1.3			
1979	80.4	19.6	100.0	37.0	0.0	37.0	30.4	0.0	30.4	13.0	13.0	26.1	0.0	6.5	6.5			
1980	49.4	50.6	100.0	22.9	1.2	24.1	25.3	26.5	51.8	1.2	19.3	20.5	0.0	3.6	3.6			
1981	41.4	58.6	100.0	12.5	0.4	12.9	23.2	13.7	36.9	5.7	44.1	49.8	0.0	0.4	0.4			
1982	72.5	27.5	100.0	34.1	0.7	34.8	34.1	3.6	37.7	4.3	23.2	27.5	0.0	0.0	0.0			
1983	56.5	43.5	100.0	18.3	0.0	18.3	27.5	8.5	35.9	10.8	34.0	44.8	0.0	1.0	1.0			
1984	58.7	41.3	100.0	10.5	1.4	12.0	39.1	10.9	50.0	9.1	26.8	35.9	0.0	2.2	2.2			
1985	75.8	24.2	100.0	30.3	0.0	30.3	30.3	9.1	39.4	15.2	15.2	30.3	0.0	0.0	0.0			
1986	37.3	62.7	100.0	0.0	0.7	0.7	31.0	19.0	50.0	4.2	33.8	38.0	2.1	9.2	11.3			
1987	41.4	58.6	100.0	9.5	0.0	9.5	9.9	3.2	13.1	21.6	52.3	73.9	0.5	3.2	3.6			
1988	70.3	29.7	100.0	30.5	0.0	30.5	28.5	9.8	38.2	10.6	16.7	27.2	0.8	3.3	4.1			
1989	59.3	40.7	100.0	4.5	0.0	4.5	39.1	10.0	49.1	15.7	27.8	43.6	0.0	2.9	2.9			
1990	63.0	37.0	100.0	26.5	0.0	26.5	21.5	4.5	26.0	14.0	29.8	43.8	1.0	2.8	3.8			
1991	59.0	41.0	100.0	10.3	0.0	10.3	38.4	16.7	55.0	10.1	21.7	31.7	0.3	2.6	2.9			
1992	58.7	41.3	100.0	9.5	0.0	9.5	35.9	2.2	38.1	12.7	38.1	50.8	0.6	1.0	1.6			
1993	57.9	42.1	100.0	14.9	0.0	14.9	33.0	7.9	41.0	13.5	32.1	45.6	0.0	2.1	2.1			
1994	59.6	40.4	100.0 [d]	3.8	0.0	3.8	56.5	6.8	63.3	9.4	24.9	34.3	0.2	4.5	4.7			

[a] Samples collected mainly by carcass survey. In some years a very few fish were also collected by beach seine or hook and line.
[b] Includes one age-3 male.
[c] Sample percentages not weighted by time period or escapement counts.
[d] Sex ratio based on total number of carcasses sampled.

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Appendix H. Climatological and hydrological observations, Anvik River sonar site, 1994.

Date	Time	Precip. (Code) [a]	Wind (Direction and Velocity)	Cloud Cover (Code [b]	Temperature: Air Min. °C	Temperature: Air Max. °C	Temperature: Instant. Water °C	Water Gauge: Actual (ft.)	Water Gauge: Relative (ft.)	Water Gauge: Relative (cm)	Water Color (code) [c]	Comments
17-Jun	18:30	N	S 10-15	1	12	19	14	3.02	0.00	0.0	Br	All instruments installed no later than 1500 h.
18-Jun	18:15	N	S 5	1	7	17	14	2.92	-0.10	-3.0	Br	Strong winds and overcast in am; clearing by noon; nice by 2000
19-Jun	18:30	I	S 10-15	4	6	17	13	2.80	-0.22	-6.7	Br	windy and rain
20-Jun	18:00	I	S 5-10	4	7	14	11	2.78	-0.24	-7.3	Br	cloudy and cool
21-Jun	18:15	R	S 10-15	4	8	16	10	2.94	-0.08	-2.4	Br	moved water gauge in toward shore: change = +0.94 ft
22-Jun	17:50	N	S 5-10	4	9	11	9	3.98	0.96	29.3	Br	moved water gauge in toward shore: change = +1.10 ft
23-Jun	18:30	N	calm	4	6	14	9	4.34	1.32	40.2	Br	river cresting: 2.60 ft at 1000
24-Jun	18:45	I	calm	4	12	16	10	3.74	0.72	21.9	Dk	
25-Jun	18:00	I	S 10-15	3	6	16	10	4.48	1.46	44.5	Br	
26-Jun	18:10	N	S 10-15	2	3	15	10	4.94	1.92	58.5	Br	finally some sunshine
27-Jun	18:00	N	N 5	3	6	16	10	4.79	1.77	53.9	Br	moved water gauge in toward shore: change = +0.43 ft
28-Jun	18:30	N	S 5	4	-2	14	9	4.09	1.07	32.6	Br	moved water gauge out: change = -0.04 ft; cold at night
29-Jun	18:30	N	N 5	2	6	18	10	3.72	0.70	21.3	Lt	clear
30-Jun	18:30	N	S 5-10	1	2	23	14	3.63	0.61	18.6	Br	sunny skies at last
01-Jul	18:30	N	S 20-30	4	16	22	12	4.71	1.69	51.5	Br	very strong winds
02-Jul	20:40	N	S 5	3	9	21	13	4.63	1.61	49.1	Br	
03-Jul	18:15	I	S 5-10	3	9	15	12	4.52	1.50	45.7	Br	rain off and on all day
04-Jul	18:30	I	S 5-10	4	8	16	12	4.47	1.45	44.2	Br	rain off and on; river water still dropping
05-Jul	18:40	I	Var 5-10	4	8	12	12	4.49	1.47	44.8	Br	same weather; rain overcast
06-Jul	18:05	N	S 10-15	2	5	16	11	4.45	1.43	43.6	Br	
07-Jul	19:15	N	S 15-20	2	6	15	11	4.19	1.17	35.7	Br	moved water gauge out: change =-0.10 ft
08-Jul	17:35	I	S 5-10	4	8	15	11	4.17	1.15	35.1	Br	cool and damp
09-Jul	17:05	N	S 1-5	2	9	16	13	4.41	1.39	42.4	Br	sunny and breezy
10-Jul	18:35	N	S 5-10	2	2	17	11	5.09	2.07	63.1	Tr	cloudy and cool
11-Jul	17:40	I	S 1-5	4	11	18	11	4.87	1.85	56.4	Tr	overcast and cool
12-Jul	18:30	I	S 1-5	4	12	17	12	5.41	2.39	72.8	Tr	moved water gauge toward shore: change =+1.30 ft
13-Jul	18:20	N	calm	3	12	24	13	5.43	2.41	73.5	Dk	nice day -- warm
14-Jul	17:43	I	S 10-15	3	8	24	14	5.40	2.38	72.5	Dk	
15-Jul	18:50	N	S 10-15	2	11	18	15	5.57	2.55	77.7	Dk	
16-Jul	17:45	N	S 0-5	1	12	21	16	4.89	1.87	57.0	Br	sunny and warm
17-Jul	18:30	N	Var 10-15	3	8	24	17	4.69	1.67	50.9	Br	cloudy with thunder storms
18-Jul	19:30	N	Var 5	2	12	25	16	4.57	1.55	47.2	Br	moved water gauge out: change = -0.66 ft
19-Jul	17:55	N	S 10-15	4	9	21	11	4.39	1.37	41.8	Tr	
20-Jul	18:25	I	S 5-10	4	9	15	13	4.19	1.17	35.7	Br	
21-Jul	18:00	N	S 5-10	4	12	17	13	4.17	1.15	35.1	Br	
22-Jul	18:40	N	S 5-10	3	12	18	13	4.09	1.07	32.6	Br	
23-Jul	18:40	R	S 5-10	4	12	17	12	4.00	0.98	29.9	Br	pouring again.

[a] Precipitation code for the preceding 24-h period: N = No precipitation; I = Intermittent rain; R = Continuous rain; S = Snow; S&R = Snow and rain mixedH = Hail; and T = Thunder showers.
[b] Instanteous cloud cover code: 0 = No observation; 1 = Clear sky, cloud cover not more than 10% of sky; 2 = Cloud cover not more than 50% of sky; 3 = Cloud cover more than 50% but less than 100% of sky; 4 = Completely overcast; and 5 = Fog or thick haze.
[c] Instantaneous water color code: Cl = Clear; Lt = Light brown; Br = Brown; Dk = Dark brown; and Tr = Turbid: murky or glacial.

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