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Estimates of Total Abundance, Exploitation Rate, and Migratory Timing of Chinook Salmon Runs in the Yukon River, 1982-1986

by

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ABSTRACT

Total run size estimated for Canadian origin (Upper Run) chinook salmon (*Oncorhynchus tshawytscha* Walbaum) of the Yukon River has averaged 120,316 chinook salmon for the 1982-86 period with an average exploitation rate of 82%. Run size varied from 90,536 in 1984 to 144,527 in 1983 and exploitation rates varied from 70% in 1984 to 90% in 1985. A maximum sustained exploitation rate of 67% was proposed for the Yukon River chinook salmon run based on production estimates from other chinook salmon stocks coastwide. Migratory timing statistics for entry into the Yukon River Delta were estimated for the Lower, Middle (Alaska Origin), and Upper Runs (Canadian Origin) of chinook salmon. The only consistent difference in timing between runs was the arrival of the Lower Run being later than the Middle and Upper. Overall there has been an increase in the proportion of Lower Run fish in early catches. Estimates of exploitation rates and total abundance for Alaska origin chinook salmon were made using the exploitation rate of Upper Run chinook salmon by assuming similar catchability and migratory timing in the lower river where they are mixed. In any given year the assumption of good mixing of the runs may have been violated, and, at best, a 30-50% range of exploitation rates for the Lower Run and 58-70% for the Middle Run was proposed.

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INTRODUCTION

A primary goal of fishery management is to control the exploitation of a population or assemblage of populations to obtain user group benefits as defined by regulatory authority. This generic goal is often specifically defined as the maximum sustainable yield (MSY). To achieve MSY in salmon resource management, certain parameters must be estimated for each contributing stock. Total abundance is the most important of these parameters along with the magnitude of associated harvests. Other biological characteristics of the stock, such as distribution, age, sex, and size composition of both the harvest and spawning population, are also needed to define MSY. Time series of such data are used by biologists to evaluate productivity at various levels of abundance. Harvest strategies can then be developed to bring the population to a level of abundance which provides MSY. Calculation of the return per spawner from each brood year is most commonly used to estimate production. Models developed by Ricker (1954) are generally fit to observed return per spawner data in order to calculate the escapement which produces MSY.

Time series of abundance observations for wild chinook salmon Oncorhynchus tshawytscha (*Walbaum*) stocks in most cases have been weakly documented because escapement estimates are rarely complete. Harvests may be well documented (McBride and Wilcock 1983) and may even be allocated to stock of origin for mixed stock fisheries (McBride et al. 1985). Age, sex, and length characteristics of major stocks have been estimated with a theorized level of precision and accuracy, and distribution of the spawning populations is generally known. However, because of wide stock distribution and costly escapement enumeration procedures, total abundance estimation has often been hampered. Return per spawner estimates have been based on incomplete data and have not been widely published.

Total escapement counts were made of fall chinook salmon passing upstream of the Bonneville Dam on the Columbia River for the 1947 through 1959 brood years (Van Hyning 1973). A Ricker-type curve fit to these data resulted in an optimum escapement of 100,000 fish producing a return per spawner of 3 to 1. A much higher level of production was observed for the years 1938 to 1962, averaging about 6 to 1.

When total escapement is not known and estimates of spawning escapements are made only for major concentrations, the return per spawner for an area will be much higher than the true value. Pearse (1982) estimated the optimum escapements for seven major chinook production areas in British Columbia, Canada, resulting in return per spawner estimates from 2.1 to 9.3, and averaging 4.4. Biologists from this area (M. Hendersen, Canadian Department of Fisheries and Oceans, Vancouver, B.C., personal communication) indicated that total escapement has not been known and that unless observed escapements are expanded to represent the total escapement, these estimates of return per spawner would continue to be too high. Likewise, Healey (1982) estimated a return per spawner of 7.1 when the spawning stock was maintained at the MSY level and observed escapements were not expanded. A return per spawner of 4.1 was proposed when these data were further adjusted to represent adult equivalents for the catch of immature fish. Using varying estimates of marine natural mortality these data were reanalyzed by Starr (Canadian Department of Fisheries and Oceans, Vancouver, B.C., personal communication), and the resulting values dropped to between 3.2 and 3.6 returns per spawner. According to Mel Seibel, (Alaska Department of Fish and Game, Juneau, personal communication), Starr's analysis was generally accepted in negotiations between the U.S. and Canada regarding chinook stocks harvested in common.

Few production estimates have been made for Alaskan chinook salmon stocks. Using return at age data by Minard (1985) and estimates of escapement by Nelson (1985), return per spawner values for the Nushagak River chinook salmon runs have ranged from 1.2 to 9.2 and have averaged 3.6 for the 1966–78 brood years

(Nelson 1987). Minard (Alaska Department of Fish and Game, Dillingham, personal communication) also estimated that return per spawner values for Togiak River chinook runs have ranged from 0.5 to 9.2 and have averaged 2.9 for the 1967–79 brood years. Using total abundance estimates developed by Roberson (Alaska Department of Fish and Game, Glennallen, personal communication) return per spawner values for Copper River chinook runs have ranged from 2.6 to 11.4 and have averaged 6.1 for 1966–79 brood years. Spawning escapements for these Alaskan stocks were estimated from aerial surveys and their accuracy and precision are unknown. Some of the variability in return per spawner estimates could be due to the variability associated with aerial survey methods.

Similar to other chinook stocks of the eastern Pacific, data are incomplete for the Yukon River chinook run. There is a real need to estimate current exploitation levels, quantify the production of the stock at various levels of abundance, and define an optimum escapement level and exploitation rate.

Yukon River chinook salmon are susceptible to harvest in a number of commercial, sport, and subsistence fisheries throughout their time of ocean residence and until their anadromous spawning migration is completed. Immature and maturing fish are harvested by gill net fisheries in the North Pacific Ocean and Bering Sea and in trawl fisheries in the Bering Sea. Adult fish returning to the Yukon River are harvested in commercial, sport and subsistence fisheries that occur along almost the entire length of the river.

The major problem currently facing agencies which manage Yukon River chinook salmon is the allocation of harvest among user groups. The allocation issues which have received the most public attention are (1) the high seas interceptions of North American chinook salmon, a large proportion of which are of Yukon River origin (Rogers et al. 1984; Rogers 1987), and (2) the "equitable" harvest allocation of Canadian-origin Yukon River chinook salmon among U.S. and Canadian inriver fishermen.

The Yukon River chinook salmon resource appears to be fully utilized under current management plans. Any decline in stock abundance or proposals for increased harvests by one user group requires a reallocation by the regulatory agencies. It is not known if the stock is being sustained at MSY. Given the gauntlet nature of the fishery and the wide distribution of spawning populations, it is likely that optimum exploitation has been exceeded for upriver stocks, while downriver stocks may be less utilized.

Yukon River chinook salmon stocks have been grouped into three spawning assemblages, referred to as runs, based on their geographic distribution from aerial surveys. McBride and Marshall (1983) defined the chinook salmon stocks which spawn in tributary streams that drain the Andreafsky Hills and Kaltag Mountains between river mile (RM) 100 and 500 as the Lower Run; those which spawn in Tanana River tributaries between RM 800 and 1,100 they called the Middle Run; those which spawn in tributary streams that drain the Pelly and Big Salmon Mountains between RM 1,300 and 1,800 they called the Upper Run. This designation results in the Lower and Middle Runs being in Alaska and the Upper Run in Canada. Total return information only exists for the Upper Run of Canada.

By coalescing and further analyzing data collected for Yukon River chinook salmon under seven projects being sponsored by two agencies I have, in this report, attempted to (1) reconstruct the Upper Run, the only run of the Yukon River for which sufficient return data exists, (2) begin a time series of total return and exploitation rate estimates for the Upper Run, and (3) describe the entry pattern into a major fishery of all three runs. The migratory timing statistics of these runs have been described in this report and pertinent applications to mixed stock fisheries management have been discussed. Also, optimum exploitation rates were developed using chinook salmon productivity values from other populations.

The Yukon River, with a drainage of 330,000 mi^2, is the largest river in Alaska and the fourth largest in North America. The river flows over 2,000 mi from its Canadian source in the northern Coastal Mountains of British Columbia, through the southern portion of the Yukon Territory, and from there continues through Alaska to the Bering Sea. About 60% of the drainage system is in Alaska. Water is relatively clear in the upper reaches of the drainage and in many tributaries but becomes progressively more turbid in the lower reaches of the drainage due to bank erosion, glacial silt, and tannic acid introduced from some tributary streams. The Koyukuk, Tanana, and Porcupine Rivers are major tributaries, the first two being important for chinook salmon production. Chinook salmon spawning occurs in 100 Alaskan streams (Barton 1984) and 55 Canadian Yukon River tributaries (Walker 1976). Major spawning areas or spawning migration points which are regularly monitored are the Andreafsky, Anvik, Nulato, Gisasa, Chena, and Salcha Rivers in Alaska (Figure 1); and Tatchun Creek, Little Salmon River, Big Salmon River, Nisutlin River in Canada (Figure 2), and the fishway of the Whitehorse Dam in Canada (ADF&G 1986).

Inriver commercial harvesting of Yukon River chinook salmon occurs from the river mouth into Canada (1,520 RM). The Alaskan portion of the drainage has been divided into 6 districts. Districts 1 through 5 divide the mainstem from the mouth to the U.S.-Canada border (1,224 RM). District 6 represents the lower 225 RM of the Tanana River (Figure 1). In Canada commercial fishing is allowed in the mainstem Yukon River upstream from the U.S.-Canada border to 0.5 RM downstream of the confluence with Tatchun Creek (about 20 RM downstream from the village of Carmacks). Fishermen in Alaska are licensed to fish gill nets in Alaskan Districts 1–3 (Lower Yukon) and set gill nets or fish wheels in Districts 4–6 (Upper Yukon). Fishermen may choose drift or set gill nets in the Lower Yukon. Fishermen in Canada can use either gill nets or fish wheels, although most use set gill nets during the chinook salmon season.

The harvest of chinook salmon for personal or subsistence use is allowed throughout the Alaskan portion of the Yukon River drainage. Over 1,000 families, mostly native American, in 38 villages participate in the subsistence fishery. In Canada 12 different Indian *bands* (tribes) utilize chinook salmon for personal consumption, and a *domestic* fishery (similar to Alaska's subsistence fishery) is open to a few non-native families living in remote areas.

METHODS

Data Sources

Contributions of Yukon River chinook runs to catches were estimated based on differences in scale growth (McBride and Marshall 1983). Since 1982 estimates of the run composition of catches in Districts 1 through 4 in percent and number of fish by periods have been made; contributions of the Lower, Middle, and Upper Runs to the season's total catch were also made for all other commercial districts and the subsistence harvest (Wilcock and McBride 1983; Wilcock 1984, 1985, 1986; Merritt et al. 1988). Run composition based on scale growth attributes was estimated for only the 1.3 and 1.4 age classes and formed the basis for estimating the run proportions of the other minor age classes. Catches in the Tanana River drainage were assumed to be Middle Run, and catches in the Yukon River above the confluence of the Tanana River were assumed to be Upper Run.

Commercial harvest data for Yukon River chinook salmon were tabulated from sale records (fish tickets) that processors are required to complete for each sale of fish from a licensed fisherman. The total catch for each district in Alaska and Canada for 1982 through 1986 were reported in ADF&G, Yukon Area Annual Management Reports (1982, 1983, 1984, 1985, 1986).

Estimates of the sport catch of chinook salmon in the Yukon River were only available for the Tanana River drainage (Mills 1983, 1984, 1985, 1986, 1987). These estimates were based on results of postal surveys consisting of repeated statewide mailings of questionnaires to randomly sampled Alaska sport fishing license holders.

The subsistence catch of chinook salmon in Alaska and Canada was estimated each year by village and summarized by district (ADF&G 1982, 1983, 1984, 1985, 1986). A complete census of all known subsistence fishermen was

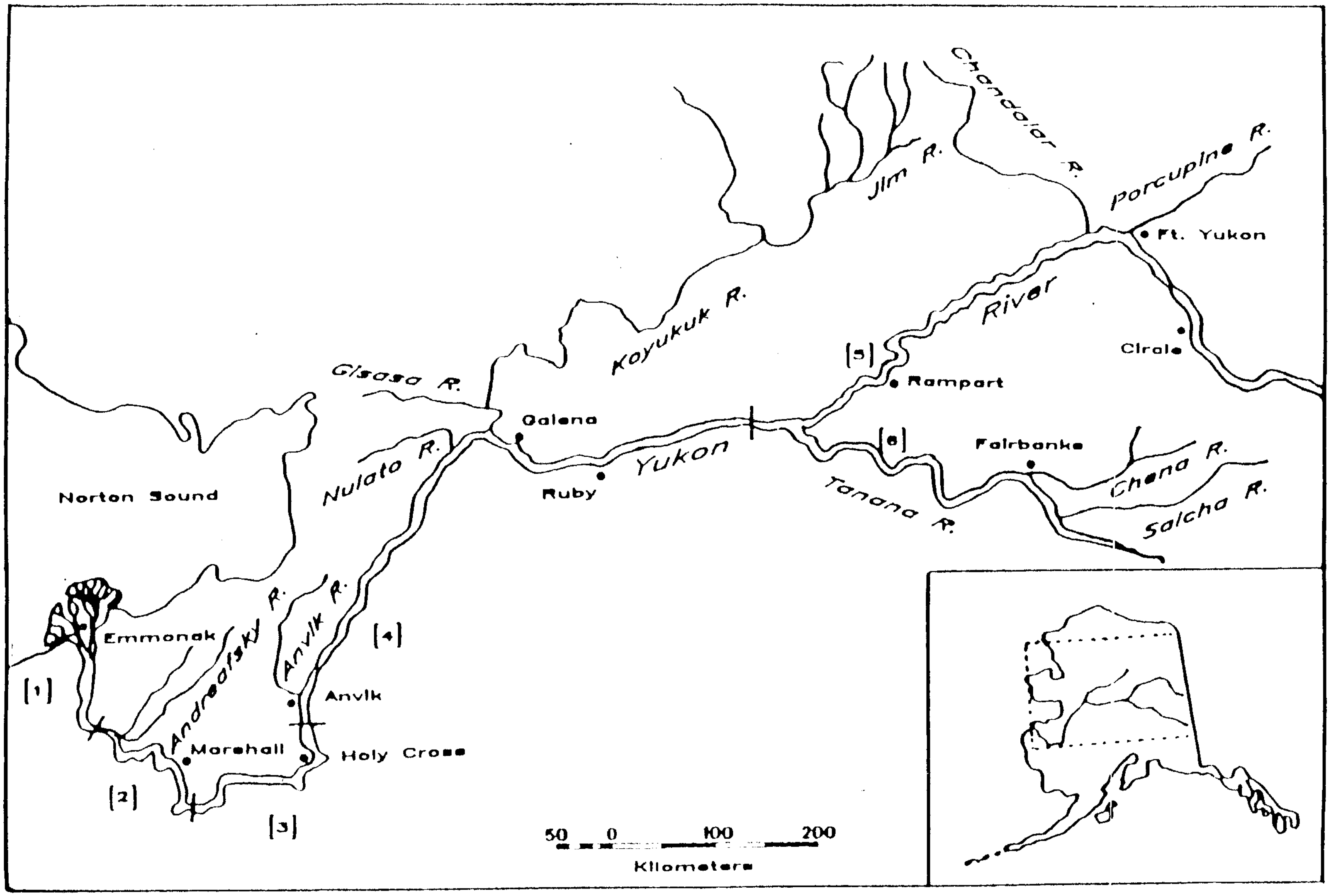


Figure 1. Alaskan portion of the Yukon River drainage showing the six regulatory districts and the major spawning tributaries for the Lower and Middle Runs of chinook salmon.

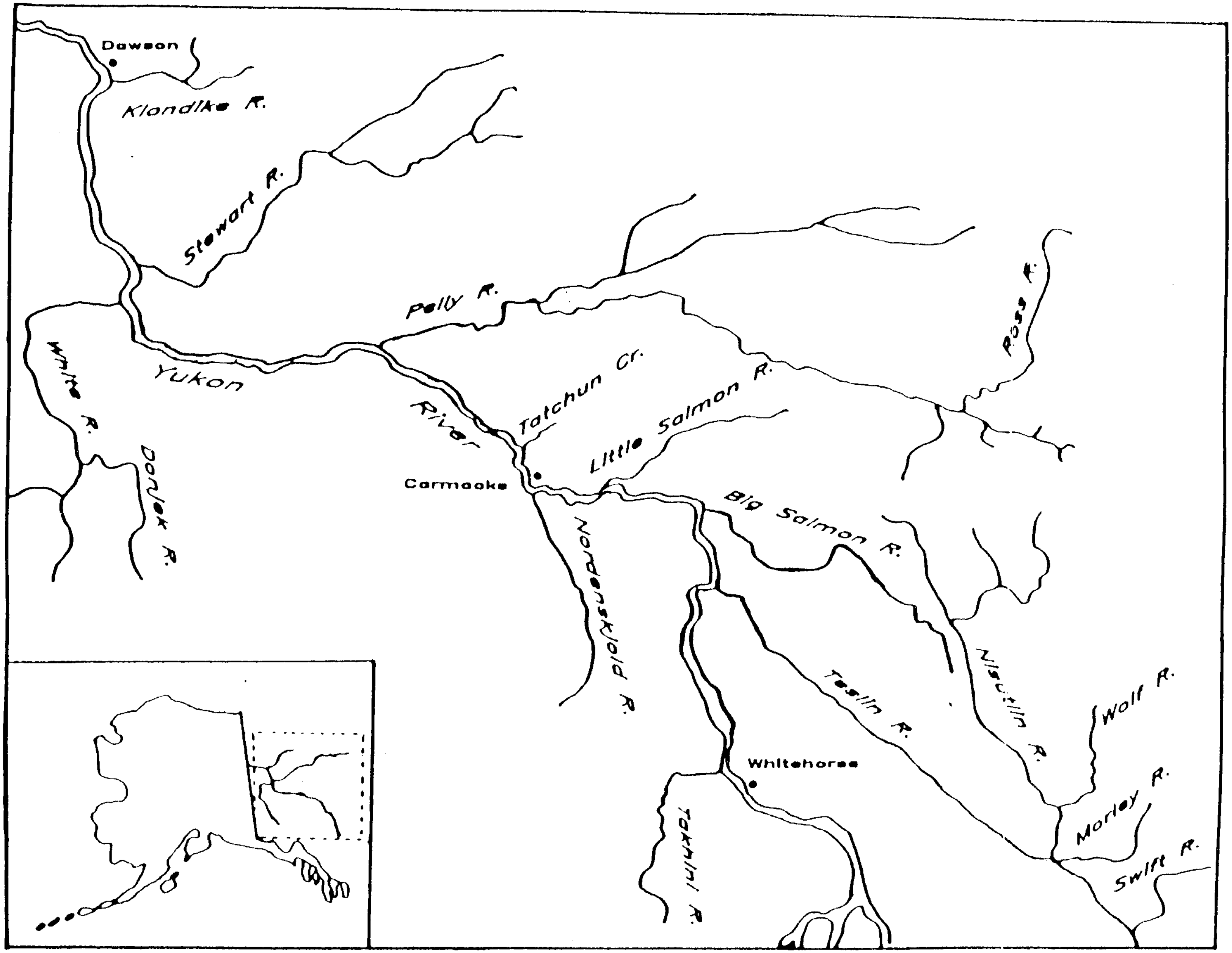


Figure 2. Canadian portion of the Yukon River drainage showing the major spawning tributaries for the Upper Run of chinook salmon.

attempted and results were expanded for missing data (Brannian and Gnath 1988).

Since 1982 the commercial fisheries in Districts 1 and 2 have been sampled each fishing period to simultaneously estimate, on a weekly basis, the true proportion of each major age class in the catch within ±5 percentage points 90% of the time ($\alpha = 0.1$). Major spawning populations have also been sampled annually (McBride et al. 1983; Buklis and Wilcock 1984, 1985, 1986; Buklis 1987).

The Alaska Department of Fish and Game (ADF&G) has conducted a test fishing program using set gill nets to index abundance of salmon returning to the Yukon River since 1963. Fishing has been done in each of the three major river mouths of the Yukon River only since 1980 (Brady 1983a, 1984; Bergstrom 1986a). Chinook salmon are thought to pass these test fish sites within District 1 early in the second day after they enter the river. Set gill nets (150 ft with 8.5-in mesh) have been used to capture chinook salmon from breakup (late May to early June) through July 15. Age, sex, and length data were collected from the catch, and scales were also used to estimate run composition prior to and following the directed chinook salmon fishery in Lower Yukon Districts 1 through 3 (Wilcock and McBride 1983; Wilcock 1984, 1985, 1986; Merritt et. al 1988).

The Canadian Department of Fisheries and Ocean (CDFO) conducted a mark and recapture program to estimate the number of salmon entering the Canadian portion of the Yukon River in 1982, 1983, (Milligan et al. 1985), 1985, and 1986 (JTC 1986). Upper Run escapement of Yukon River chinook salmon has been estimated as the difference between the Petersen estimate of population size and upriver commercial and personal use harvests. No corrections could be made for sport fishing removals because little information exists regarding catch and effort for the chinook salmon sport fishery. The variance of adjusted Petersen population estimates were made for 1982 and 1983 tagging data following methods described by Seber (1982). Insufficient intermediate data were published to estimate the variance for 1985 and 1986. An estimate of chinook salmon runs to Canada in 1984 was made by multiplying the sum of four aerial survey and fishway counts of chinook salmon by the mean ratio of the Petersen population estimate over the sum of the same four escapement counts for 1982 through 1983 and 1985 through 1986.

Total Run and Exploitation Rates for the Upper Run

Total run of the Upper Run of Yukon River chinook salmon (T_u) was estimated as the sum of commercial and subsistence harvests of Upper Run chinook salmon in Alaska and the CDFO population estimate. Total Upper Run exploitation (μ_u) was the ratio of total catch to total run. District proportion exploitation rates (μ_{ud}) were estimated as the ratio of Upper Run catch (C_{ud}) for each of the seven districts (d) to Upper Run total run (T_u) by

$$\mu_u = \sum_{d=1}^{7} \mu_{ud} , \qquad (1)$$

where $\mu_{ud} = C_{ud} T_u^{-1}$.

Estimates of exploitation by district (μ_{udP}) were defined as the proportion of the unharvested run that was captured in a particular district. Districts were numbered 1 through 6 beginning in the delta and ending at the U.S.-Canada border. The Canadian fishery was numbered 7, and District 6 (the Tanana River) was assumed to have a zero catch of Upper Run chinook salmon. Therefore, the proportion of the remaining run harvested in each district (exploitation by district) was

$$\mu_{udP} = C_{ud} \left(T_u - \sum_{e=1}^{d-1} C_{ue}\right)^{-1}, \qquad (2)$$

where C_{ue} is the Upper Run (u) catch of District (e).

The 1982–86 estimates of Upper Run total run each had an associated estimate of precision that would affect estimates of total annual exploitation. A variance was estimated for age-1.3 and -1.4 Upper Run catch in Districts 1 and 2 for 1982 and 1983, Districts 1 through 4 for 1984 and 1985, and Districts 1, 2, and 4 for 1986, where run proportions were estimated from scale attributes (Merritt et al. 1988). This variance represented the precision of only 37% (1984) to 59% (1985) of the Upper Run catch in Alaska. In addition, the coefficient of variation (CV) associated with these estimates of Upper Run age-1.3 and -1.4 fish steadily decreased from 55.4% in 1982 to 4.5% in 1986 as a result of improved sample design and an increase in scale collection sample size. Variances were not estimated for catches of the minor age classes or the subsistence harvest in these districts. It was assumed that the CV calculated for age-1.3 and -1.4 chinook salmon applied to the total harvests in Districts 1–4. The product of the estimated CV and Upper Run catch was used as an estimate of variance for Districts 1–4 harvests. District 5 and Canadian harvests were assumed to be measured without error, so their variance was zero.

Data needed to estimate a variance for the CDFO population estimate of Yukon chinook salmon crossing the U.S.-Canada border were published only for 1982 and 1983. The resulting CV was 11% in 1982 and 5% in 1983. Because project design and sampling effort have not changed, the average CV (8%) was used to estimate a variance for 1984–86 spawning escapement estimates. Variance of the total run was the sum of individual variances for Districts 1–4, District 5, and the CDFO population estimate.

Total Run and Exploitation Rates for the Middle and Lower Runs

Middle Run (T_m), or Lower Run (T_l), total chinook salmon abundance was estimated from district (d) catches of Middle Run (C_{md}) or Lower Run (C_{ld}) chinook salmon and Upper Run district proportion exploitation rates (μ_{ud}). For example, the Middle Run total run was

$$T_m = \sum_{d=1}^{D} C_{md} \left(\sum_{d=1}^{D} \mu_{ud} \right)^{-1}, \qquad (3)$$

and the total exploitation of Middle Run chinook salmon was

$$\mu_m = \sum_{d=1}^{6} C_{md} \, T_m^{-1}. \qquad (4)$$

The number of districts (D) used for calculations each year was restricted to those with sampling programs for estimating run proportions of the catch. Some minor catches were assigned the run composition of neighboring districts. Thus, cumulative catch and exploitation from Districts 1–4 were used for 1984 through 1986, Districts 1–3 were used for 1983, and Districts 1 and 2 for 1982. Total run and exploitation for the Lower Run were estimated in a similar manner.

Age composition of spawning escapements for each run was estimated by pooling samples from individual spawning tributaries within each of the three defined regions. The Kruskal-Wallis test (Conover 1980) was used to test the hypothesis that length distribution by age was identical among runs of Yukon River chinook salmon. Approximate p-values of the Kruskal-Wallis test were based on the chi-square distribution. All tests were made at the $\alpha = 0.05$ level of significance.

Migratory Timing

The mathematical description of migratory timing and its summary statistics follow the convention described by Mundy (1984) in which the time density function (f_i) for each chinook salmon run was defined as

$$f_i = n_i \left(\sum n_i \right)^{-1}, \qquad (5)$$

the mean of the time density function ($\bar{t}$) was defined as

$$\bar{t} = \sum_{\text{all } i} i f_i , \qquad (6)$$

and the variance (S^2) was estimated as

$$S^2 = \sum_{\text{all } i} (i - \bar{t})^2 f_i , \qquad (7)$$

where n_i is the number of chinook salmon from time period i.

Day 1 of the migration was defined as June 1. Test fishery data were used to estimate the migratory timing of the Yukon River chinook salmon runs because they provided a continuous time series of data from late May through July 15 (Bergstrom 1986a). In contrast, commercial fishing was begun after the test fishery had documented a period of 7–10 d of increasing catches (ADF&G 1987). Historically, chinook salmon were the targeted species of the commercial fishery, and mesh size for gill nets was not restricted. As fleet and processing efficiencies increased during the 1980's, the period for directed chinook salmon harvest was reduced from six 24-h fishing periods spanning 3 weeks in 1982 to three 24-h fishing periods spanning 8 d in 1985. When the allowable catch of chinook salmon was reached, the maximum allowed mesh size was set at 6 in, and chum salmon (*O. keta*) became the targeted species. At this time a portion of the chinook salmon run may have not yet entered the river. Therefore, the restricted mesh size and resultant change in chinook salmon catchability during the chum season would not produce a consistent index of abundance across the entire run for purposes of estimating a migratory time density function.

Several data sets were combined to estimate the run composition of test fishing CPUE from 1982 to 1986. Test fishing chinook catches were sampled for scales and formed the basis for run composition estimates for the period prior to the commercial fishing season. Thereafter, only commercial catches were sampled for scales during both the restricted and unrestricted mesh periods. It was necessary to apply the estimates of run composition in District 1 commercial catches to test fishing CPUE. Stock composition estimates were made only for age-1.3 and -1.4 chinook salmon. Stock composition of younger ages were estimated based on results from age-1.3 analyses; estimates for older ages were based on the age-1.4 analyses. The proportions of a daily test fishing CPUE (S_{kj}) for run j in period k were based on an average of the two major age groups' proportion by run (P_{kja} where a = age 1.3 or 1.4), weighted by the proportion (q_{ka}) of that age in the test fishery or unrestricted mesh size commercial catch, as follows:

$$S_{kj} = P_{kj1.3}\, q_{k1.3} + P_{kj1.4}\, q_{k1.4} \ , \qquad (8)$$

An estimate of run composition from the commercial or test fishery was not available for every day of test fishing CPUE. Therefore, it was necessary to apply the run proportion estimates (S_{kj}) from commercial period k or the preseason test fishing period to test fishing CPUE for more than one day. District 1 was 63 RM in length and fish were thought to be vulnerable to capture for 2 or 3 d as they migrated upstream. Fish were also thought to pass the test fish sites early in the second day after they entered the district. Run proportion estimates from each commercial period k were applied to 3 d of test fishery CPUE beginning the day before and ending the day after the k^{th} period. Stock compositions of six daily test fishery CPUE were assigned in this manner from the two commercial periods per week; the 7th, generally Saturday, was assigned using the run proportion estimates of the following Monday. Therefore, the CPUE (D_i) of day i that was of run j (D_{ij}) was estimated as

$$D_{ij} = D_i\, S_{kj} \ , \qquad (9)$$

where S_{kj} was used for $i = k-1,\ k,\ k+1$ and, less often, $k+2$.

Migratory timing statistics have been published for Yukon River chinook salmon based on commercial fishing data for 1961 to 1980 (Mundy et al. 1981a) and test fishery data for 1963 to 1979 (Mundy et al. 1981b; Clark 1983).

The sum of the squared differences (SS_k) between the cumulative proportions (Σf_{ik}) of Upper (U) and either the Lower (L) or Middle (M) Runs was used to judge how closely the entry patterns of any two runs agreed on a daily basis (or the degree of parallelism). The sum of squares for the difference between run k and Upper Run chinook salmon was

$$SS_k = \sum_{all\ j} \left(\sum_{i=1}^{j} f_{ik} - \sum_{i=1}^{j} f_{iu} \right)^2 \ , \qquad (10)$$

where $k = L$ or M.

RESULTS

Abundance and Exploitation Rates for the Upper Run

The average run size of the Upper Run chinook salmon for 1982 through 1986 was 120,316 fish; it underwent an 82% exploitation rate and represented 53 % of the catch for the entire Yukon River. In 1982, 84% of the total run of 124,487 Upper Run chinook salmon were harvested (Table 1). This comprised 62% of the catch for the entire Yukon River. The largest run for the Upper Run during this period was 144,527 chinook salmon in 1983, of which 80% were harvested, comprising 53% of the drainage-wide catch (Table 2); the smallest run was in 1984. It also underwent the lowest total exploitation: 70% (Table 3). The highest exploitation of Upper Run chinook salmon occurred in 1985 when 90% of a 112,571-fish run was harvested (Table 4). In 1986 the Upper Run proportion of the total Yukon River chinook catch was the highest of the 5-year period, accounting for 68% of the run and representing an exploitation rate of 87% (Table 5).

The Canadian fishery exhibited the greatest district exploitation rate (μ_{udP}) on the Upper Run, harvesting 37% (1984) to 63% (1985). The District 5 and 1 fisheries exhibited similar district exploitation rates (μ_{udP}) of 30% (1984) to 38% (1985) and 32% (1983) to 34% (1982), respectively. The smallest district exploitation rates were recorded in Districts 3 and 4, which harvested less than 10% of the Upper Run. In contrast, the greatest harvests of Upper Run chinook salmon occurred in Districts 1 and 2, which had a combined exploitation rate of 46% (1983) to 52% (1982). Only in 1984 was the harvest of Upper Run chinook salmon in District 5 and Canada greater than the combined District 1 and 2 harvest.

Small CVs for estimates of Upper Run total abundance produced small variances and resulted in small differences between the upper and lower bounds of 90% confidence intervals. When the lower bounds of the 90% confidence interval for catch and for escapement were used in calculations of total exploitation (μ_u), in 4 out of 5 years (1983–1986) rates were greater than when upper bounds were used (Table 6). Total exploitation rates based on confidence intervals of total runs were asymmetrical. The difference between exploitation rates estimated from the upper and lower bound of total run was greatest in 1982 (10%) and least in 1983 (< 1%).

Analysis of Abundance and Exploitation Rates for the Middle and Lower Runs

Knowing that all three runs share a common migration route through the Lower Yukon Area, I was able to use Upper Run exploitation rates to estimate the Lower and Middle Run exploitation rates, allowing estimation of Middle and Lower Run total abundance. This required an important assumption of equal vulnerability to harvest of all three runs in the Lower Yukon River Area. To determine how well mixed and similarly vulnerable the three runs are to capture in the Lower Yukon Area, I examined (1) migratory timing by run, (2) vulnerability to capture during the chinook salmon fishery, and (3) the size distribution and age composition of the runs in relation to the type of gear being fished.

Migratory Timing

The ability to estimate the run composition of Lower Yukon area harvests from scale analysis combined with the continuous in-season sampling of the entire run at test fishery sites allowed for the estimation of the migratory entry pattern of each run of origin for 1982 through 1986. Similar time of entry into the river (mean and variance) would support my assumption that good mixing of all three runs and similar exploitation rates occurred in the Lower Yukon area.

For the pooled run, the mean date of entry varied from 15 June in 1983 with a variance of 115.8 to 30 June in 1985 with a variance of 40.8 (Table 7). Mundy (1982) classified yearly runs as early, normal, or late based on a 95% confidence interval ($19.4 < x < 23.1$) around the grand mean of 21.3 for 1961 through 1980. Since 1980, 2 years were early (1981 and 1983), 1 year had normal timing (1986), and 3 years were late (1982, 1984, and 1985).

In 1982 the mean date of the Lower Run was 9 d later than that of either the Middle or Upper Runs (Appendix A; Figure 3). The Lower Run comprised less than 10% of total daily test fishing CPUE through 22 June and greater than 50% after 29 June (Appendix B). In 1983 there was also temporal separation of the Lower Run from the Upper and Middle Runs (Figure 3; Appendix C). The Lower Run again comprised less than 10% of the daily CPUE through 17 June and 44.8% beginning 29 June (Appendix D). Chinook runs to the Yukon River were compressed from 1984 through 1986 in that the variances were small and there was little temporal separation between the runs. In 1984 the Lower Run represented 35.2% of the early test fishing catches and increased to 60.2% by 27 June (Appendix E). The span between mean dates for the three runs was 4.2 d, with the Middle Run entering first (Figure 4; Appendix F). Again there was little temporal separation among runs in 1985, although the Middle Run was somewhat early and compressed (Figure 4; Appendix G). The Middle Run represented only 16.2% of preseason catches and were absent after 3 July (Appendix H). The chinook salmon run in 1986 had the least temporal separation among runs. The Upper and Lower Runs entered together (Figure 5), but the Middle Run had passed through the delta by 24 June (Appendix I). The Lower Run comprised less than 13% prior to 18 June and increased to 48.5% by 28 June (Appendix J).

Run-specific test fishing CPUE was used as an index of relative abundance for comparison among years and runs. Again in 1982 and 1983 (Figure 6) early catches were comprised of Upper and Middle Run fish. Clearly, harvesting after 25 June would have targeted on Lower Run fish, but

Table 1. Estimates of catch, catch proportions, and exploitation rates by run of origin and district for Yukon River chinook salmon, 1982.

District	Total Catch	Total Catch (No. of Fish) by Run of Origin			Proportion of Catch by Run			Upper Run Exploitation Rates[a]		
		Lower	Middle	Upper	Lower	Middle	Upper	by District	Dist. Prop.	Cum. Expl.
1	76,761	17,743	16,815	42,203	0.23	0.22	0.55	0.34	0.34	0.34
2	41,241	5,777	13,078	22,386	0.14	0.32	0.54	0.27	0.18	0.52
3	5,968	429	1,870	3,669	0.07	0.31	0.61	0.06	0.03	0.55
4	5,307	0	3,894	1,413	0.00	0.73	0.27	0.03	0.01	0.56
5	18,218	0	0	18,218	0.00	0.00	1.00	0.33	0.15	0.71
6[b]	4,408	0	4,408	0	0.00	1.00	0.00	0.00	0.00	0.71
Y.T.	16,867	0	0	16,867	0.00	0.00	1.00	0.46	0.14	0.84
Koyukuk	878	0	878	0	0.00	1.00	0.00	0.00	0.00	0.84
Total	169,648	23,949	40,943	104,756	0.14	0.24	0.62			0.84
Escapement				19,731						
Total Run				124,487						
Exploitation Rate				0.84						

[a] By District exploitation rate is (μ_{udP}) or the proportion harvested from what is left after downstream removals. For example, District 2 exploitation = (District 2 Catch)/(Total - District 1 Catch) = (22,386)/(124,487-42,203) = 0.27. District proportion of total exploitation is (μ_{ud}) or the proportion of total run taken in each district. For example, District 5 Prop. = District 5 Catch / Total Return = 18,218 / 124,487 = 0.15. Cumulative Exploitation is ($\Sigma\mu_{ud}$) or the exploitation the run has undergone up to that district. For example, Cum. Expl. for District 4 = Cum. Catch (District 1 to District 4) / Total Return = (42,203 + 22,386 + 3,669 + 1,413) / 124,487 = 0.56.

[b] Includes Tanana drainage sport harvest (Mills 1983)

overall abundance was low for that period and the resulting harvest from a targeted chinook fishery would have been much lower. In contrast, for 1984 through 1986 (Figures 7, 8) no one period would have selected or protected one stock over another. In 1984 and 1985 the Lower Run was also strong in June, and again the pooled run strength diminished in July. In general, Lower Run strength has increased after 1982 (Table 8). There was a very weak contribution to total run by the Middle Run in 1985 and 1986.

Vulnerability to Capture Among Chinook Salmon Runs

There were three fisheries on chinook salmon runs entering the Lower Yukon River. First, a subsistence fishery occurred prior to the commercial season, and exploitation was thought to be low. Next a segment of each run was subjected to exploitation by the commercial fishery. This fishery was directed at chinook salmon and began only after 7 to 10 d of increasing test fishery catches. During this fishery simultaneous openings of Districts 2 and 3 to commercial fishing were alternated with District 1 and began 2 to 3 d after the first period in District 1. Third, some chinook salmon were harvested by the commercial gill net fishery for chum salmon which was restricted to a maximum mesh size of 6 in. Subsistence and restricted-mesh harvests represent an average 24% of the total annual chinook harvest in Districts 1–3 for 1982 through 1986.

In 1982 the commercial fishery for chinook salmon began when 23% of the Upper Run had passed the test fishery but only 3.5% of the Lower

Table 2. Estimates of catch, catch proportions, and exploitation rates by run of origin and district for Yukon River chinook salmon, 1983.

District	Total Catch	Total Catch (No. of Fish) by Run of Origin			Proportion of Catch by Run			Upper Run Exploitation Rates[a]		
		Lower	Middle	Upper	Lower	Middle	Upper	by District	Dist. Prop.	Cum. Expl.
1	101,720	14,601	41,191	45,928	0.14	0.40	0.45	0.32	0.32	0.32
2	52,294	8,737	23,672	19,885	0.17	0.45	0.38	0.20	0.14	0.46
3	9,016	238	2,109	6,669	0.03	0.23	0.74	0.08	0.05	0.50
4	8,872	0	4,928	3,944	0.00	0.56	0.44	0.05	0.03	0.53
5	20,385	0	0	20,385	0.00	0.00	1.00	0.30	0.14	0.67
6[b]	4,665	0	4,665	0	0.00	1.00	0.00	0.00	0.00	0.67
Y.T.	18,427	0	0	18,427	0.00	0.00	1.00	0.39	0.13	0.80
Koyukuk	1,483	0	1,483	0	0.00	1.00	0.00	0.00	0.00	0.80
Total	216,862	23,576	78,048	115,238	0.11	0.36	0.53			0.80
Escapement				29,289						
Total Run				144,527						
Exploitation Rate				0.80						

[a] By District exploitation rate is (μ_{udP}) or the proportion harvested from what is left after downstream removals. For example, District 2 exploitation = (District 2 Catch)/(Total - District 1 Catch) = (19,885)/(144,527-45,928) = 0.20. District proportion of total exploitation is (μ_{ud}) or the proportion of total run taken in each district. For example, District 5 Prop. = District 5 Catch / Total Return = 20,385 / 144,527 = 0.14. Cumulative Exploitation is ($\Sigma\mu_{ud}$) or the exploitation the run has undergone up to that district. For, example Cum. Expl. for District 4 = Cum. Catch (District 1 to District 4) / Total Return = (45,928 + 19,885 + 6,669 + 3,944) / 144,527 = 0.53.

[b] Includes Tanana drainage sport harvest (Mills 1984)

Run had passed (Table 9). The commercial fishery began to target on chum salmon when 93.2% of the Upper Run and only 62.8% of the Lower Run of chinook salmon had passed. Differences in timing also resulted in very different segments of the Upper and Lower Runs being vulnerable to the chinook salmon fishery in 1983. In 1984 very similar percentages of the three runs were vulnerable to the chinook salmon fishery (51.6% to 57.6%). In 1985 the commercial fishery began to target on chum salmon when 50.6% of the Upper Run had passed and 100% of the Middle Run. In 1986 only 5.4% of the Middle Run had entered the Yukon River, when the chinook fishery began, compared to 30.7% and 48.5% of the Lower and Upper Runs, respectively.

It was also assumed that the run mixture would be consistent on a daily basis and remain so as they move upriver through the various fisheries. The degree of parallelism of entry curves would indicate the consistency of daily stock compositions. Based on the squared difference between cumulative proportions, the entry pattern of the Lower Run was most parallel to the Upper Run in 1984 through 1986, while that of the Middle Run was most similar to the Upper Run in 1982 and 1983. The sum of the squared differences between the Lower and Upper Run was 3.2 and 4.4 for 1982 and 1983, respectively, and between 0.43 and 0.13 for 1984 through 1986. Similarly, the 1982-84 sum of the squared differences were < 1 for the Middle and Upper Runs and < 1.3 for 1985 and 1986. It is not

Table 3. Estimates of catch, catch proportions, and exploitation rates by run of origin and district for Yukon River chinook salmon, 1984.

District	Total Catch	Total Catch (No. of Fish) by Run of Origin			Proportion of Catch by Run			Upper Run Exploitation Rates[a]		
		Lower	Middle	Upper	Lower	Middle	Upper	by District	Dist. Prop.	Cum. Expl.
1	79,294	32,764	31,513	15,015	0.41	0.40	0.19	0.17	0.17	0.17
2	43,870	15,657	19,807	8,407	0.36	0.45	0.19	0.11	0.09	0.26
3	7,394	1,688	4,043	1,662	0.23	0.55	0.22	0.02	0.02	0.28
4	7,211	1,861	2,551	2,799	0.26	0.35	0.39	0.04	0.03	0.31
5	18,658	0	0	18,658	0.00	0.00	1.00	0.30	0.21	0.51
6[b]	4,804	0	4,804	0	0.00	1.00	0.00	0.00	0.00	0.51
Y.T.	16,495	0	0	16,495	0.00	0.00	1.00	0.37	0.18	0.70
Koyukuk	1,400	0	1,400	0	0.00	0.00	0.00	0.00	0.00	0.70
Total	179,126	51,970	64,118	63,036	0.29	0.36	0.35			0.70
Escapement				27,500[c]						
Total Run				90,536						
Exploitation Rate				0.70						

[a] By District exploitation rate is (μ_{udP}) or the proportion harvested from what is left after downstream removals. For example, District 2 exploitation = (District 2 Catch)/(Total - District 1 Catch) = (8,407)/(90,536-15,015)= 0.11. District proportion of total exploitation is (μ_{ud}) or the proportion of total run taken in each district. For example, District 5 Prop. = District 5 Catch / Total Return = 18,658 / 90,536 = 0.21. Cumulative Exploitation is ($\Sigma\mu_{ud}$) or the exploitation the run has undergone up to that district. For example, Cum. Expl. for District 4 Cum. Catch (District 1 to District 4) / Total Return = (15,015 + 8,407 + 1,662 + 2,799) / 90,536 = 0.31.

[b] Includes Tanana drainage sport harvest (Mills 1985)

[c] Escapement was expanded from aerial survey data based on the relationship between aerial survey and tagging based population estimates from 1982, 1983 and 1985.

Table 4. Estimates of catch, catch proportions, and exploitation rates by run of origin and district for Yukon River chinook salmon, 1985.

District	Total Catch	Total Catch (No. of Fish) by Run of Origin			Proportion of Catch by Run			Upper Run Exploitation Rates[a]		
		Lower	Middle	Upper	Lower	Middle	Upper	by District	Dist. Prop.	Cum. Expl.
1	93,082	40,456	16,771	35,854	0.43	0.18	0.39	0.32	0.32	0.32
2	51,833	19,208	11,730	20,894	0.37	0.23	0.40	0.27	0.19	0.50
3	5,930	924	919	4,087	0.16	0.15	0.69	0.07	0.04	0.54
4	6,884	2,802	885	3,197	0.41	0.13	0.46	0.06	0.03	0.57
5	18,508	0	0	18,508	0.00	0.00	1.00	0.38	0.16	0.73
6[b]	9,873	0	9,873	0	0.00	1.00	0.00	0.00	0.00	0.73
Y.T.	19,001	0	0	19,001	0.00	0.00	1.00	0.63	0.17	0.90
Koyukuk	1,205	0	1,205	0	0.00	1.00	0.00	0.00	0.00	0.90
Total	206,316	63,390	41,383	101,541	0.31	0.20	0.49			0.90
Escapement				11,030						
Total Run				112,571						
Exploitation Rate				0.90						

[a] By District exploitation rate is (μ_{udP}) or the proportion harvested from what is left after downstream removals. For example, District 2 exploitation = (District 2 Catch)/(Total - District 1 Catch) = (20,894)/(112,571-35,854) = 0.27. District proportion of total exploitation is (μ_{ud}) or the proportion of total run taken in each district. For example, District 5 Prop. = District 5 Catch / Total Return = 18,508 / 112,571 =0.16. Cumulative Exploitation is ($\Sigma\mu_{ud}$) or the exploitation the run has undergone up to thatdistrict. For example, Cum. Expl. for District 4 Cum. Catch (District 1 to District 4) / Total Return = (35,854 + 20,894 + 4,087 + 3,197) / 112,571 = 0.57.

[b] Includes Tanana drainage sport harvest (Mills 1986)

known whether differences among the three runs were due to differences in migratory routes taken through the delta area with its multiple channels, distribution within the main river channel, or mere sampling error.

Size and Age Similarities

Estimates of Middle and Lower Run total run based on Upper Run exploitation rates also involved the assumption that chinook salmon from all runs would have the same size and age distribution. If the three runs differed in their age compositions (and, therefore, length distributions) different proportions of each run would be captured in different fisheries because of the selective nature of the gear. A greater proportion of the run with a high proportion of large chinook salmon, usually older age groups, would be removed by the large mesh gill net fishery. Conversely, a larger proportion of the run with a high proportion of small chinook salmon, usually of younger age groups, would be removed by the fish wheel fisheries. Comparison (Kruskal-Wallis test) among runs of the length distribution in 1986 of age-1.3 and -1.4 fish produced no significant (0.05) differences ($p < 0.05$, df=2).

Only age data were readily available to examine the size composition of spawning escapements for 1982 through 1986. The age composition of the Middle Run more closely resembled the Upper Run in years with a strong age-1.5 component. In all years there was a greater proportion of younger age groups (age-1.2 and 1.3) in Lower Run escapements than in

Table 5. Estimates of catch, catch proportions, and exploitation rates by run of origin and district for Yukon River chinook salmon, 1986.

District	Total Catch	Total Catch (No. of Fish) by Run of Origin			Proportion of Catch by Run			Upper Run Exploitation Rates[a]		
		Lower	Middle	Upper	Lower	Middle	Upper	by District	Dist. Prop.	Cum. Expl.
1	58,309	21.214	1,988	35,107	0.36	0.03	0.60	0.27	0.27	0.27
2	48,325	17,894	355	30,076	0.37	0.01	0.62	0.32	0.23	0.50
3	5,152	2,211	94	2,847	0.43	0.02	0.55	0.04	0.02	0.53
4	9,144	2,873	377	5,897	0.31	0.04	0.64	0.10	0.05	0.57
5	18,721	0	0	18,721	0.00	0.00	1.00	0.34	0.14	0.72
6[b]	5,177	0	5,177	0	0.00	1.00	0.00	0.00	0.00	0.72
Y.T.	19,764	0	0	19,764	0.00	0.00	1.00	0.54	0.15	0.87
Koyukuk	941	0	941	0	0.00	0.00	0.00	0.00	0.00	0.87
Total	165,533	44,192	8,932	112,412	0.27	0.05	0.68			0.87
Escapement				17,068						
Total Run				129,480						
Exploitation Rate				0.87						

[a] By District exploitation rate is (μ_{udP}) or the proportion harvested from what is left after downstream removals. For example, District 2 exploitation = (District 2 Catch)/(Total - District 1 Catch) = (30,076)/(129,480-35,107) = 0.32. District proportion of total exploitation is (μ_{ud}) or the proportion of total run taken in each district. For example, District 5 Prop. = District 5 Catch / Total Return = 18,721 / 129,480 = 0.14. Cumulative Exploitation is ($\Sigma\mu_{ud}$) or the exploitation the run has undergone up to that district. For example, Cum. Expl. for District 4 Cum. Catch (District 1 to District 4) / Total Return = (35,107 + 30,076 + 2,847 + 5,897) / 129,480 = 0.57.

[b] Includes Tanana drainage sport harvest (Mills 1987)

either Middle or Upper Run escapements (Figure 9). This could have been due to differences in (1) age of maturity, (2) the selective properties of fishing gear used in the various districts, or (3) year class strengths between runs. Only in 1986 were sufficient samples collected to describe the age composition of chinook salmon caught in fish wheels in District 5. The age composition of the total spawning population which entered this district (i.e., the sum of age-specific abundance estimates for District 5 catches, Canadian harvests, and spawning escapements) was very similar to the Upper Run escapement and lacked the younger age classes present in Lower Run escapements.

However, age composition of catches and escapements in 1986 may have been anomalous because there was a much stronger than average run of age-1.3 chinook salmon that year. In addition, commercial fishing patterns in 1986 were altered; 6-in gill net mesh periods were set prior to and alternated with unrestricted mesh size periods during the gill net fishery directed on chinook salmon in Districts 1 and 2. A redesign of the sampling program will be needed to examine this problem in future years to address this issue.

Abundance and Exploitation Rates

Estimates for the Lower and Middle Runs were a function of the cumulative exploitation rate of the Upper Run for District 1-4 ($\Sigma\ \mu_{ud}$). The 1982-86 exploitation of the Lower Run was estimated to range from 31% to 57%, while the total run ranged from 45,231 to 167,645 chinook

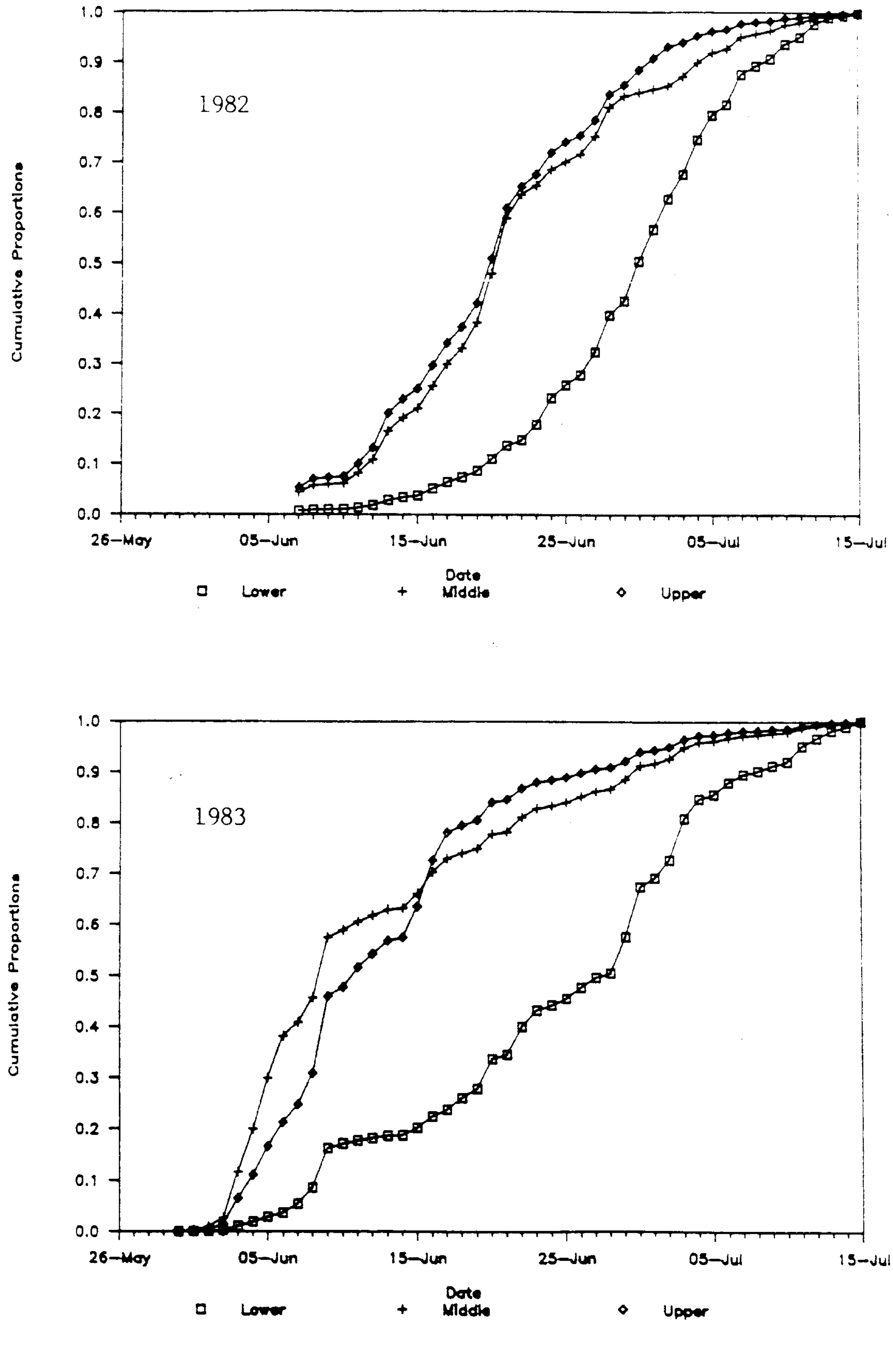
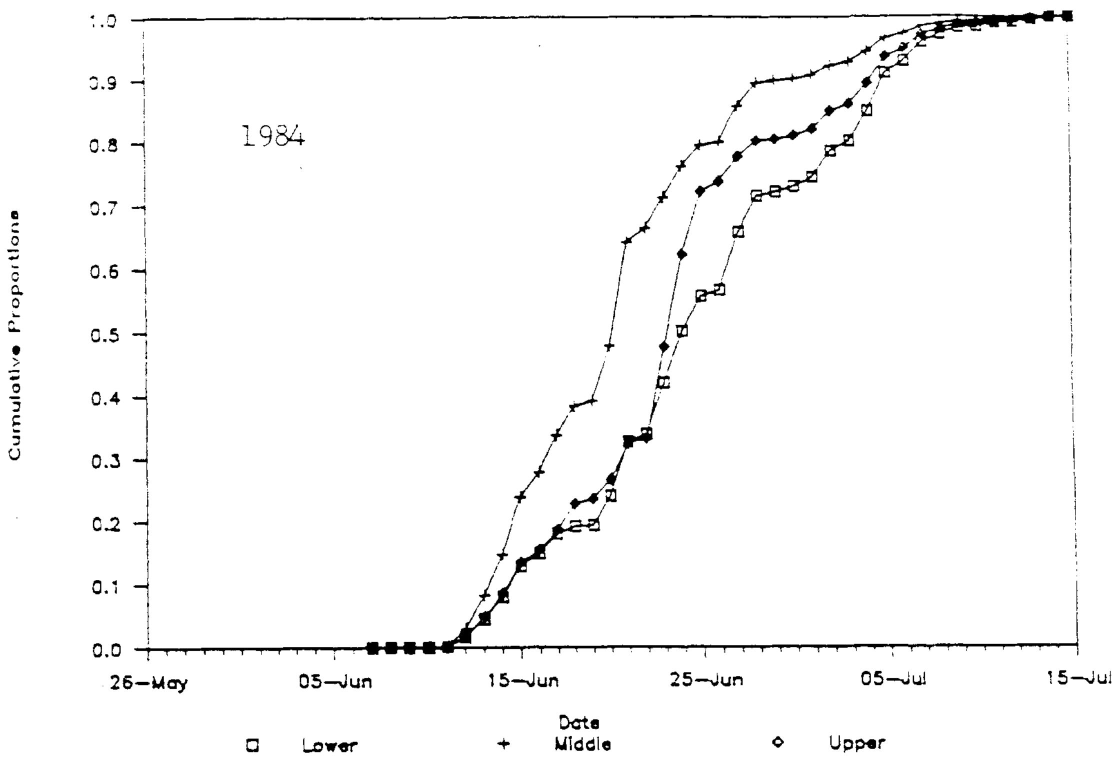


Figure 3. Cumulative proportions of total chinook salmon CPUE by date and run for the Lower Yukon River test fishery for 1982 (top) and 1983 (bottom).



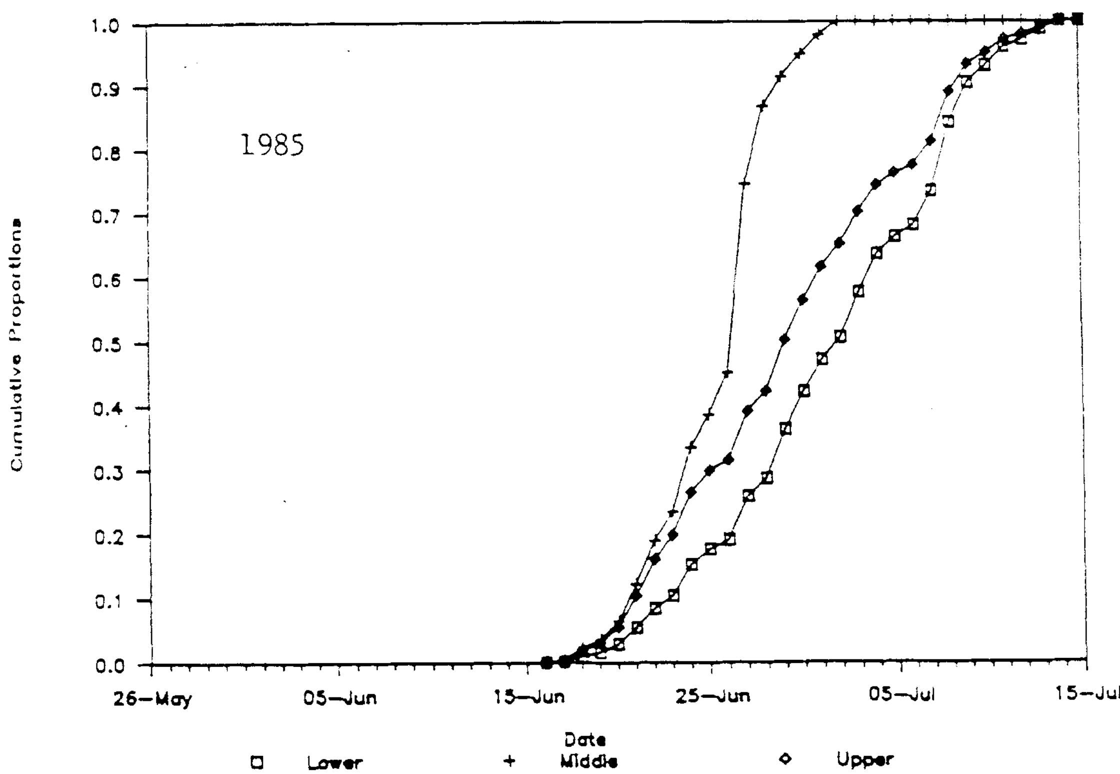


Figure 4. Cumulative proportions of total chinook salmon CPUE by date and run for the Lower Yukon River test fishery for 1984 (top) and 1985 (bottom).

Table 6. Estimates of total exploitation of the Upper Run of Yukon River chinook salmon using approximate 90% confidence bounds of catch and escapement.

	Exploitation Rates Using Total Return 90% Confidence Interval		
Year	Lower Bound of Total Return	Estimate	Upper Bound of Total Return
1982	76%	84%	86%
1983	80%	80%	79%
1984	72%	70%	68%
1985	93%	90%	88%
1986	90%	87%	84%

salmon (Table 10). Middle Run exploitation rates were estimated to range from 34% to 181% , (an impossible upper value), while total run varied from 4,929 to 188,047 chinook salmon.

DISCUSSION

Total exploitation rate of the Upper Run averaged 82% for 1982 through 1986. This level of exploitation may be excessive and could lead to dramatic declines in future runs. Return per spawner values for other western Alaska stocks of chinook salmon average 2.9 (Togiak River; R.E. Minard, Alaska Department of Fish and Game, Dillingham, personal communication) to 3.6 (Nushagak River; Nelson 1987). A total exploitation rate of 65% to 72% should sustain population size at these levels of production. Major British Columbia chinook populations are estimated to produce at 3.2 to 3.6 return per spawner when maintained at MSY. Without additional information a conservative approach for

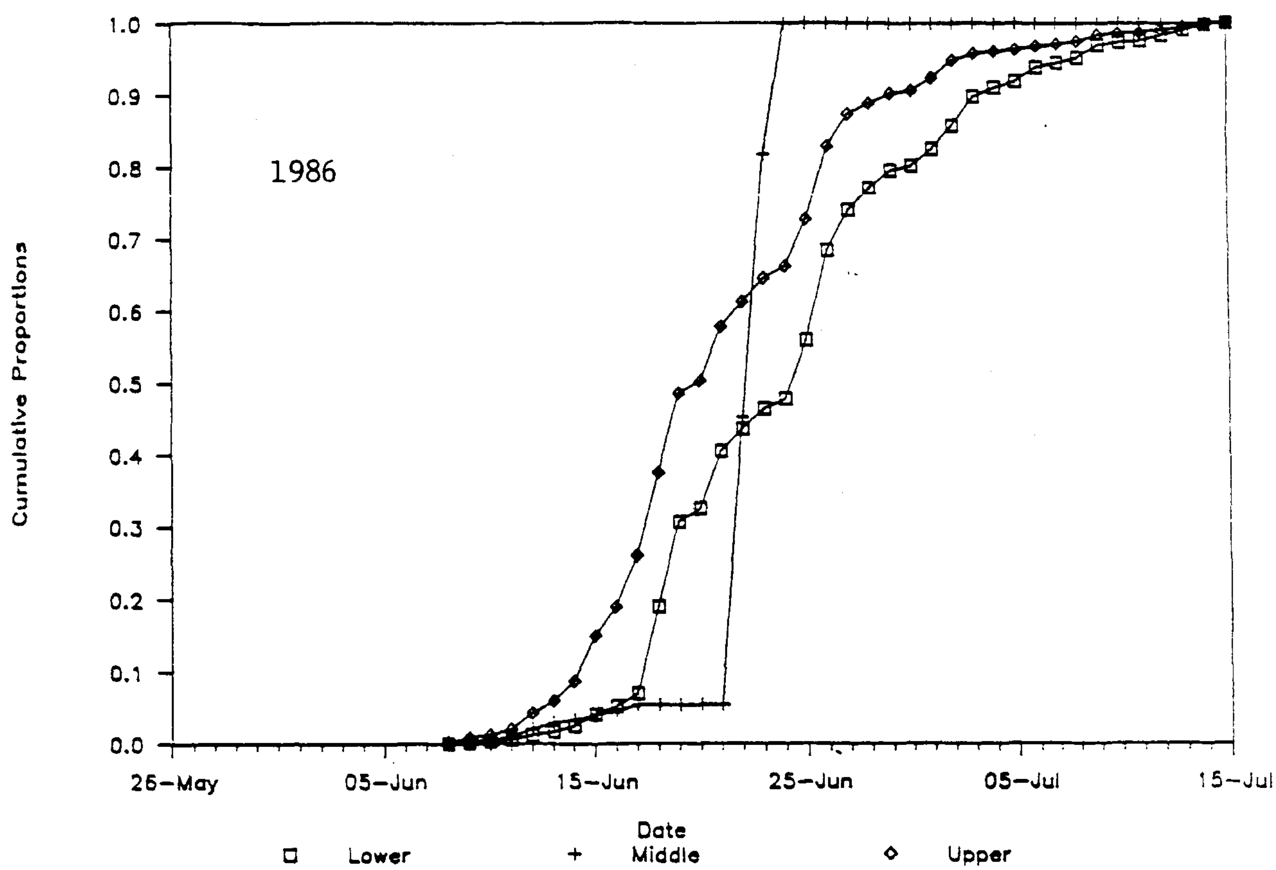
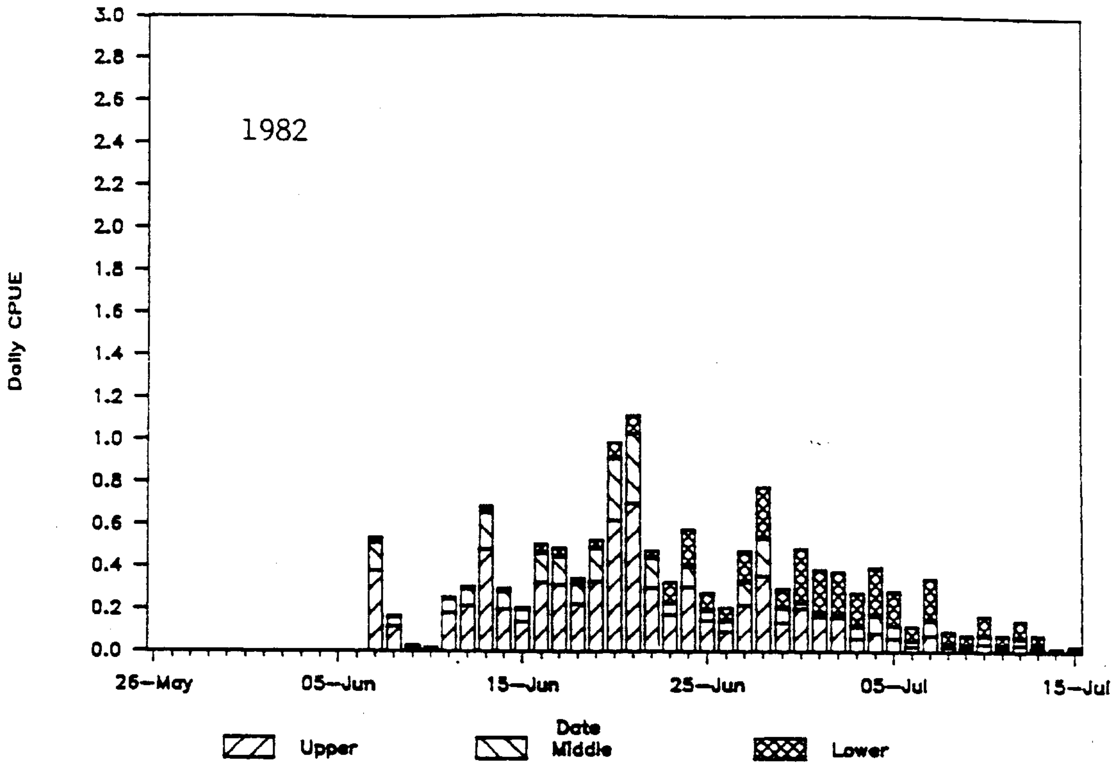


Figure 5. Cumulative proportions of total chinook salmon CPUE by date and run for the Lower Yukon River test fishery for 1986.



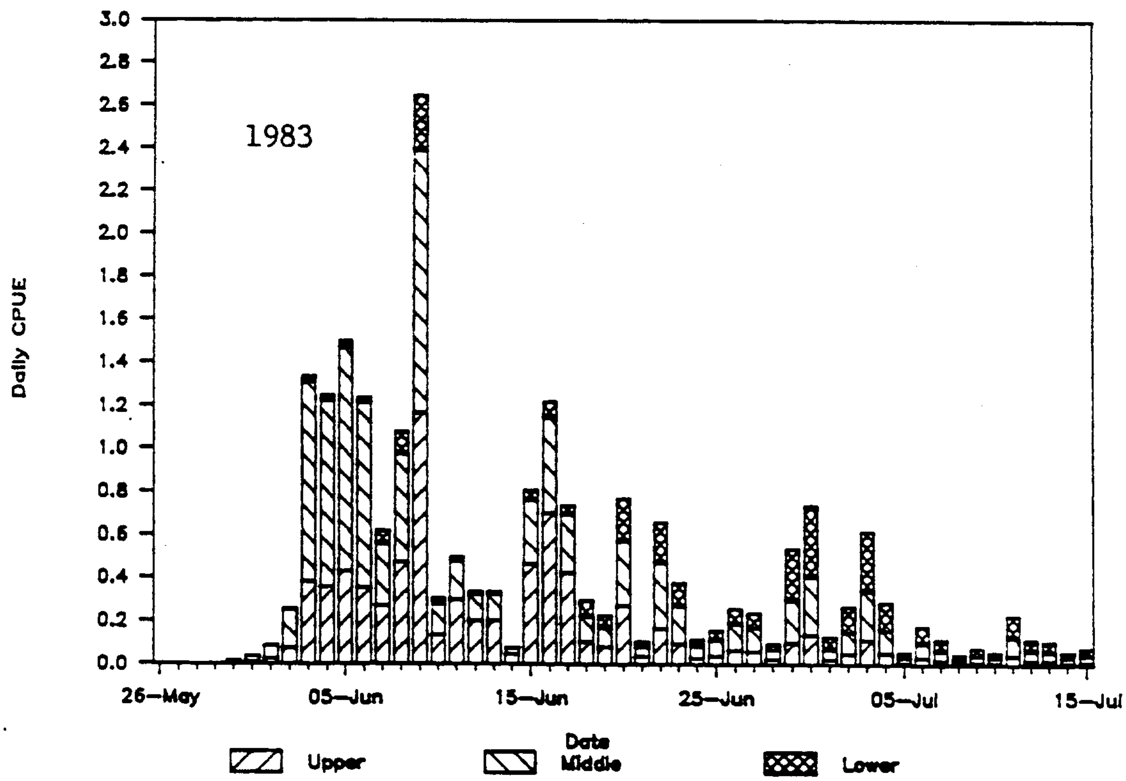
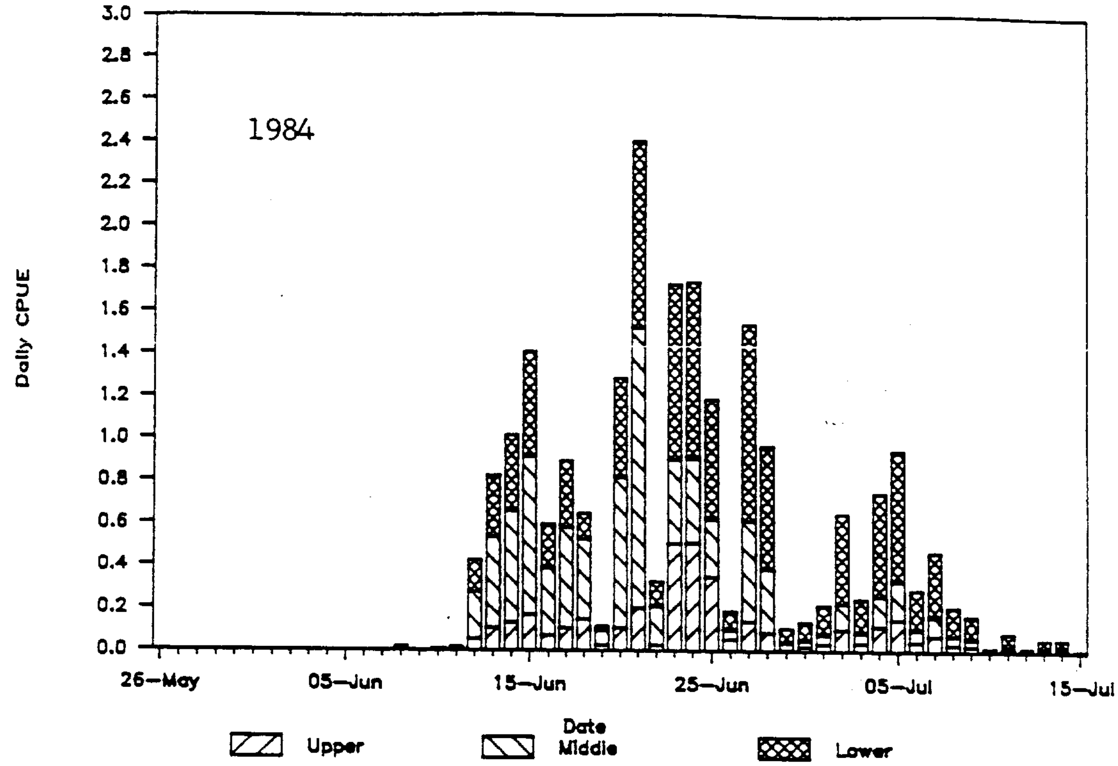


Figure 6. Estimated run proportions for the daily CPUE from the Lower Yukon River test fishery in 1982 (top) and 1983 (bottom).



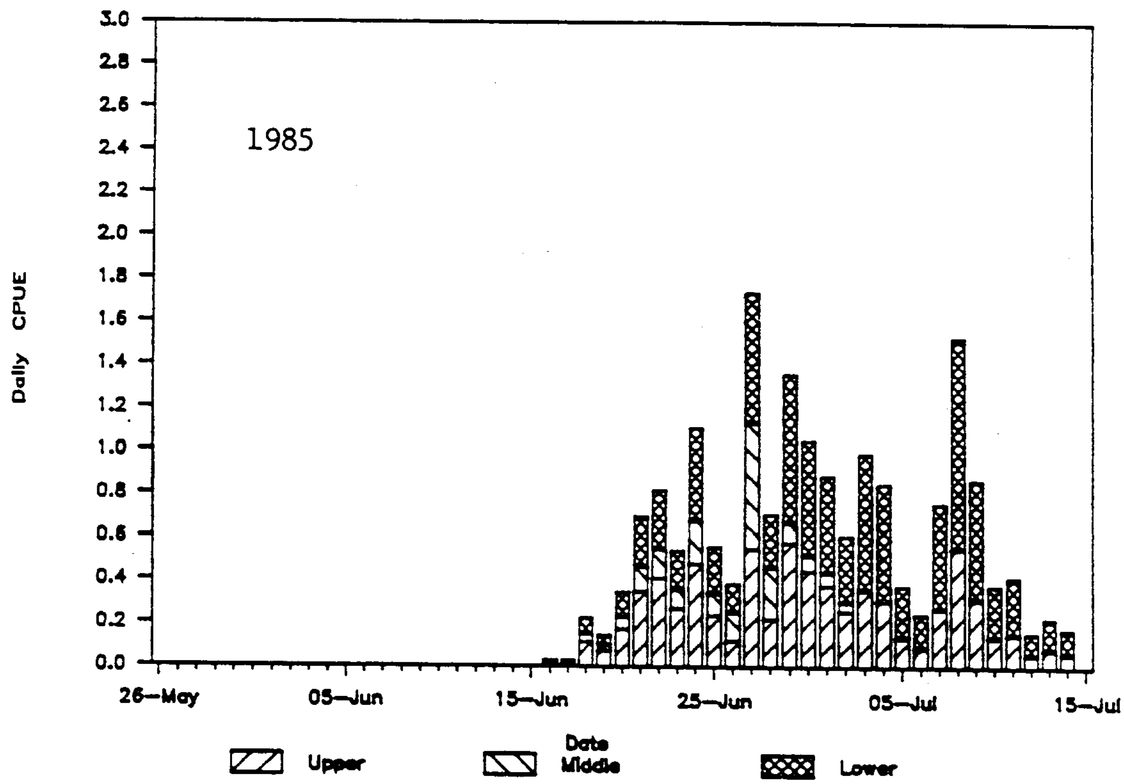


Figure 7. Estimated run proportions for the daily CPUE from the Lower Yukon River test fishery in 1984 (top) and 1985 (bottom).

Table 7. The mean freshwater entry date and variance for Yukon River chinook salmon by run of origin based on the run proportions of test fishery CPUE from 8.5 inch mesh nets.

Origin		Mean Day of Freshwater Entry By Year[a]							
		1980	1981	1982	1983	1984	1985	1986	1987
All Stocks	Mean	18.6	15.5	23.3	15.1	23.5	30.5	22.6	24.1
	Variance	75.5	87.4	74.5	115.8	51.6	40.8	43.5	75.1
Lower	Mean			29.8	25.0	25.3	32.0	24.7	
	Variance			53.2	113.1	54.1	38.7	45.4	
Middle	Mean			21.9	13.0	21.1	25.7	22.3	
	Variance			69.8	108.3	40.9	9.8	5.4	
Upper	Mean			20.8	13.5	24.0	29.9	21.6	
	Variance			59.5	75.9	45.8	42.3	40.3	

[a] Where days are counted beginning with June 1 as day 1.

the Yukon River would assume an average production of 3.0 returns per spawner and allow a maximum sustainable exploitation rate of 67% until sufficient brood year return data becomes available for more detailed analysis. On the Yukon River this level has been exceeded every year of the 5 years studied and is outside the approximate 90% confidence bounds for total exploitation rate.

If the Upper Run was over-exploited during the 1982-86 period, this would raise concern for the status of the Middle and Lower Runs of Yukon River chinook salmon. All share a common upriver migration through the Lower Yukon (Districts 1 through 3) where 72% of the drainage-wide harvest was taken, of which 90% was sold commercially (1982–86 average). In contrast, total Upper Yukon area harvests in the Alaska portion of the drainage averaged 83% subsistence (1982–86). This use maintains a priority use before commercial and sport fishing.

If conservation measures are taken, they will need to be taken first in the Lower Yukon. This requires the greatest harvest reduction because for every 100 chinook salmon foregone in the catch only 44 would be of Upper Run origin (1982–86 average). A more effective conservation program would require additional restrictions to

Table 8. Cumulative chinook CPUE on July 15 from the test fishery in the Lower Yukon River for all stocks pooled and by run of origin, 1982-86.

Region of Origin	Cumulative CPUE[a] by Year				
	1982	1983	1984	1985	1986
All Stocks	13.4	21.5	21.9	18.3	22.2
Lower	3.3	3.4	10.2	9.1	7.2
Middle	3.0	10.4	8.2	2.0	0.4
Upper	7.1	7.7	3.5	7.2	14.6

[a] Project has operated since 1980 at current locations and effort levels. The July 15 cumulative CPUE was 33.8 in 1980, 32.7 in 1981, and 31.7 in 1987.

commercial and subsistence fishermen throughout the migration of Upper Run chinook salmon. Estimates of total run and exploitation rate for the Middle and Lower Runs were needed to decide whether exploitation rates should be lowered on all stocks together or on a stock-specific

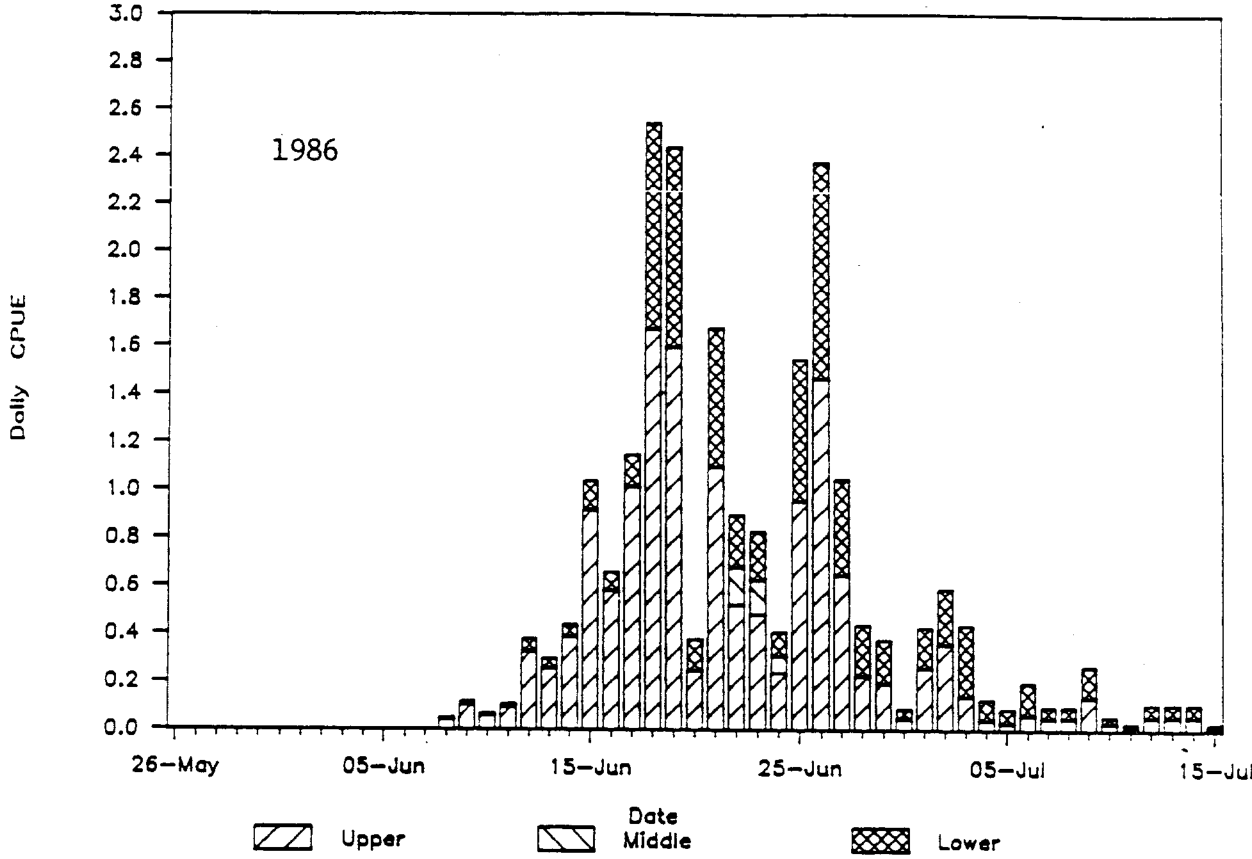


Figure 8. **Estimated run proportions for the daily CPUE from the lower Yukon River test fishery in 1986.**

basis. The minimum needed was an indication of whether their exploitation was higher or lower than the Upper Run.

Estimates of total run and total exploitation of Middle and Lower Run chinook salmon were made from Upper Run exploitation rates under the assumption that all three runs were equally vulnerable to capture within each district in the shared migratory route. However, the rate of exploitation on a run can vary because of (1) discontinuous execution of the fishery, (2) uneven distribution of effort, and (3) the size-selective nature of the capture gear. Therefore, the accuracy of estimates of total run and exploitation rate for the Middle and Lower Runs depends on whether these runs were subjected to the same fishing mortality in the Lower Yukon Area, as was the Upper Run.

There is evidence that this assumption has been violated. If so, the three runs may have undergone different exploitation rates; the Lower Run may have been exploited at a lower rate and may be more abundant than estimated in this study. First, migratory timing differed between the Upper and Lower Runs in 1982 and 1983. In both years the Lower Run entered the Yukon River later than the Upper Run with 30%-60% of the Lower Run entering after the fishery directed on chinook salmon. Therefore, the Upper Run exploitation rate would overestimate the Lower Run rate, resulting in an underestimate of total abundance. Second, Lower Run escapements have consistently differed in age composition (and therefore overall length distribution) from Upper Run escapements. If these differences were not due to gear selectivity or sampling problems, these runs would have had different

Table 9. Cumulative percent of each run past the test fishery site at the beginning and ending dates of the chinook salmon directed fishery in District 1 of the Yukon River, 1982-86.

Year	Start Date	Cumulative Percent			Ending Date	Cumulative Percent			Percent Vulnerable to Fishery		
		Lower	Middle	Upper		Lower	Middle	Upper	Lower	Middle	Upper
1982	6-14	3.5	19.3	23.0	7-02	62.8	85.4	93.2	59.3	66.1	70.2
1983	6-09	16.3	57.6	46.0	6-21	34.6	73.8	84.6	18.3	16.2	38.6
1984	6-18	19.2	38.3	22.8	6-29	72.1	89.9	80.4	52.9	51.6	57.6
1985	6-24	15.3	33.5	26.5	7-02	50.6	100.0	65.2	35.3	66.5	38.7
1986	6-19	30.7	5.4	48.5	7-04	91.9	100.0	96.3	61.2	94.6	47.8

catchabilities in the Lower Yukon gill net fishery. If the Lower Run was comprised of a greater proportion of younger and smaller chinook salmon, it would have been (1) less vulnerable to the directed chinook salmon fishery in which fisherman most commonly used 8.5-in mesh gill nets (Brady 1983b; Bergstrom 1986b), and (2) more vulnerable to the directed chum salmon fishery where 6-in mesh gill nets were commonly used. How this might affect accuracy of exploitation rates and abundance estimates is unknown. Finally, based on the distance of their migration up the mainstem Yukon River, the Lower Run would have undergone a substantially lower total exploitation than the Upper Run as it passed through two fewer fishing districts. Therefore, the range of 30-50% total exploitation estimated from Upper Run exploitation would be a reason-

Table 10. Total return in numbers of fish and exploitation rates estimated for the Lower and Middle Run of Yukon River chinook salmon, 1982-86. Estimates were a function of the exploitation of Upper Run fish in their shared route based on assumed equal vulnerability to capture.

Year	Lower Run		Middle Run		Upper Run	
	Total Return	Exploitation Rate	Total Return	Exploitation Rate	Total Return	Exploitation Rate
1982	45,231[ab]	53%	57,615	71%	124,487	84%
1983	47,152[ab]	50%	133,541	58%	144,527	80%
1984	167,645[b]	31%	188,047	34%	90,536	70%
1985	111,210[b]	57%	53,277[a]	78%	112,571	90%
1986	77,529[b]	57%	4,929[ac]	181%[c]	129,480	87%

[a] These estimates may be inaccurate due to dissimilar migratory timing with the upper run.

[b] These estimates may be inaccurate due to dissimilar age at maturity with the upper run.

[c] This is an impossible value and is presented to demonstrate the consequences of violating the assumptions underlying its estimation.

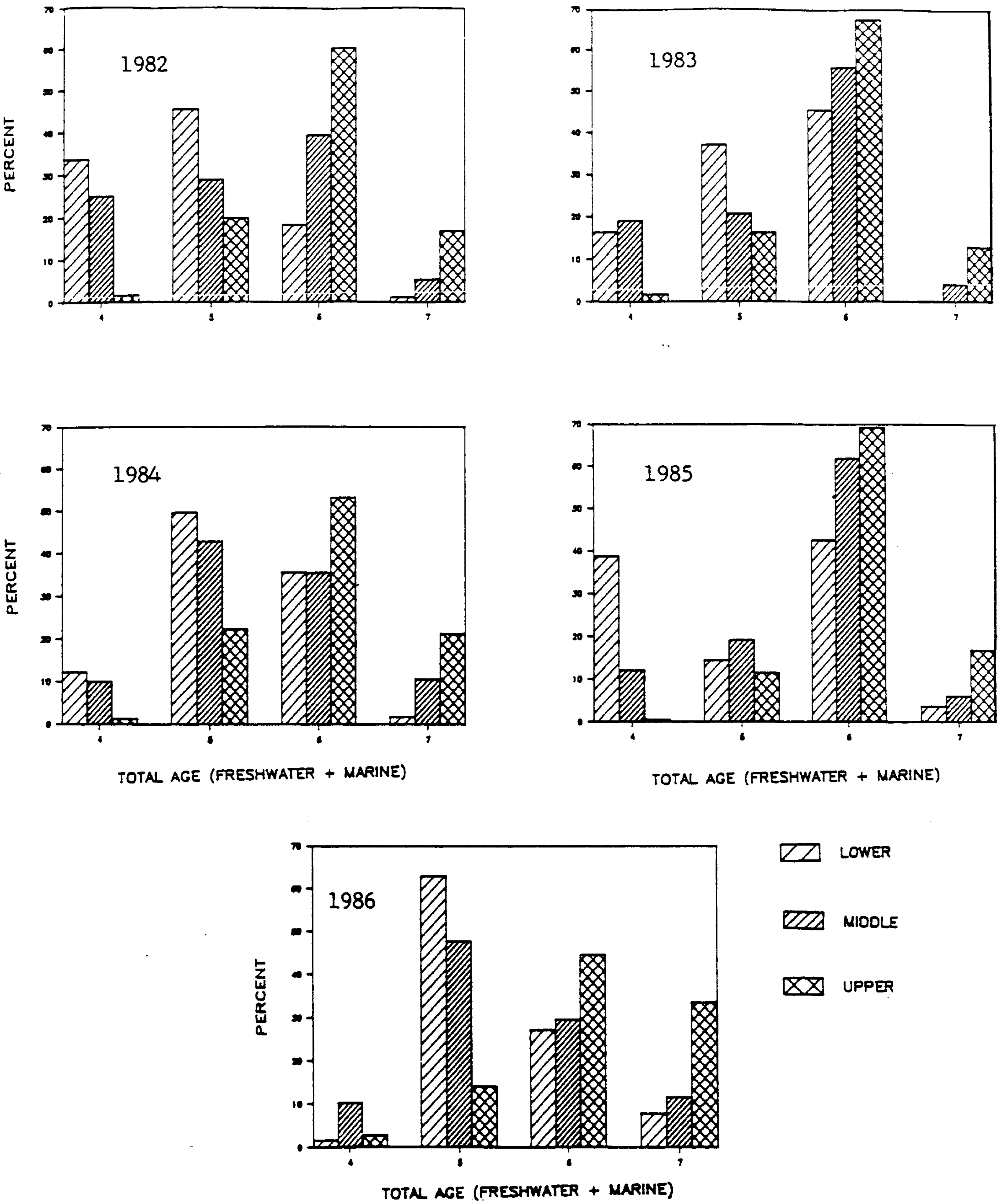


Figure 9. Percent by total age (freshwater and marine) of escapement samples for the Lower, Middle, and Upper Runs of chinook salmon in the Yukon River, 1982-86.

able first estimate, but violations of underlying assumptions negate any statement concerning total exploitation rate in any particular year.

Differences in migratory timing between the Middle and Upper Runs also put in question estimates of Middle Run total run and exploitation in 1985 and 1986. In 1985 the Middle Run entered before the Upper Run, and a greater proportion was vulnerable to the Lower Yukon fishery. Therefore, the Upper Run exploitation rate may have underestimated the Middle Run rate and overestimated its total abundance. In 1986 the upper-end 181% exploitation rate estimated for the Middle Run was obviously an impossible value. The Middle Run was mysteriously absent from Lower Yukon catches in 1986, representing less than 5% of the catch in Districts 1-4. This resulted in a total run estimate of 4,929 chinook salmon which was also unrealistically low because the spawning escapement into a major Middle Run tributary, the Chena River, was estimated by Barton (1987) to be 9,065 chinook salmon. Therefore, the Upper Run exploitation rate overestimated that of the Middle Run in 1986, though for unknown reasons.

Lastly, based on observations of spawning abundance and distribution, it was very unlikely that the Lower and Middle Runs were each twice as large as the Upper Run in 1984. It is more likely that use of the Upper Run exploitation rate resulted in underestimation of the Lower and Middle Runs exploitation in that year. In general, one would expect the Middle Run total exploitation to be less than the Upper Run based on the number of fisheries each pass through. So, while the Middle Run may not have been greatly overexploited, it may have been at, or just above, the proposed maximum exploitation rate of 67% in some years.

Although the accuracy of estimates of total run and exploitation of Middle and Lower Runs may be questioned for the 5 years examined, the information gained in attempting to estimate these values was worthwhile. An appreciation was needed for the differences in exploitation rates one would expect given the gauntlet nature of the fisheries in the Yukon River drainage. The range of expected exploitation rates for these two runs of 30% to 50% for the Lower Run and 58% to 70% for the Middle Run could be used as a starting point for addressing mixed stock management concerns in the Yukon River.

With acceptance of the differences in current exploitation rates between the Upper, Middle, and Lower Runs, stock-specific management would be appropriate. Consistent temporal separation of the runs would allow managers to differentially harvest by run in the Lower Yukon Area. However, migratory timing statistics for runs exhibited few consistent trends. The Lower Run had the latest mean date for all years. The time span between the earliest and latest mean dates for the three runs has ranged from 12 d in 1983 to 3.1 d in 1986. In general, the Upper and Middle Runs enter together, with the mean differing by < 1 d in 1983 and 1986 to 4.2 d in 1985. For 3 of the 5 years the Middle Run entered slightly earlier. Only in 1982 and 1983 was the temporal separation between any of the runs great enough to support differential harvests. Annual differences in migration timing among the three runs varied greatly, and because this information is available only after the fishing season, it does not provide for a change in the current management strategy.

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 1982. Annual management report 1982 Yukon area. Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

ADF&G (Alaska Department of Fish and Game). 1983. Annual management report 1983 Yukon area. Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

ADF&G (Alaska Department of Fish and Game). 1984. Annual management report1984 Yukon area. Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

ADF&G (Alaska Department of Fish and Game). 1985. Annual management report 1985 Yukon area. Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

ADF&G (Alaska Department of Fish and Game). 1986. Annual management report 1986 Yukon area. Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

ADF&G (Alaska Department of Fish and Game). 1987. Yukon area commercial and subsistence salmon fisheries, 1987 management plan. Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

Barton, L.H. 1984. A catalog of Yukon River salmon spawning escapement surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 121, Juneau.

Barton, L.H. 1987. Population estimate of chinook salmon escapement in the Chena River in 1986, based upon mark and recapture techniques. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region III: Yukon Salmon Escapement Report 31 (unpublished), Anchorage.

Bergstrom, D. F. 1986a. Lower Yukon River salmon spawning escapement surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region III: Yukon Salmon Test Fish Report 21 (unpublished), Anchorage.

Bergstrom, D.F. 1986b. Lower Yukon River commercial salmon fishing fleet investigations, 1984-1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region III: Gear Survey Report 3 (unpublished), Anchorage.

Brady, J. 1983a. Lower Yukon River salmon test and commercial fisheries, 1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 89, Juneau.

Brady, J. 1983b. Lower Yukon commercial fishing fleet investigations, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region III: Gear Survey Report 1 (unpublished), Anchorage.

Brady, J. 1984. Lower Yukon River salmon test fishing studies, 1982-1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region III: Yukon Salmon Test Fish Reports 19 (unpublished), Anchorage.

Brannian, L.K., and D.G. Gnath. 1988. Subsistence harvest of Pacific salmon in the Yukon River drainage Alaska, 1986 with an historical review. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Research Bulletin 88-03, Juneau.

Buklis, L.S. 1987. Age, sex, and size of Yukon River salmon catch and escapement, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 221, Juneau.

Buklis, L.S., and J.A. Wilcock. 1984. Age, sex, and size of Yukon River salmon catch and escapement, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 119, Juneau.

Buklis, L.S., and J.A. Wilcock. 1985. Age, sex, and size of Yukon River salmon catch and escapement, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 148, Juneau.

Buklis, L.S., and J.A. Wilcock. 1986. Age, sex, and size of Yukon River salmon catch and escapement, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 176, Juneau.

Clark, J.E. 1983. Parameter estimation for a class of models scribing the migratory timing of chinook salmon (*Oncorhynchus tshawytscha*) in the lower Yukon River, Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 224, Juneau.

Conover, W.J. 1980. Practical nonparametric statistics, edition 2. John Wiley and Sons, New York.

Healey, M.C. 1982. Catch, escapement and stock-recruitment for British Columbia chinook salmon since 1951. Canadian Department of Fisheries and Oceans, Canadian Technical Report of Fisheries and Aquatic Sciences 1107, Nanaimo, British Columbia.

JTC (Joint Canada/United States Yukon River Technical Committee). 1986. Yukon River Technical Report: September 23-25, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, (Region 3 unpublished report), Anchorage.

McBride, D.N., H.H. Hamner, and L.S. Buklis. 1983. Age, sex, and size of Yukon River salmon catch and escapement, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 90, Juneau.

McBride, D.N., and S.L. Marshall. 1983. Feasibility of scale pattern analysis to identify the origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the lower Yukon River commercial gill net fishery, 1980-1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 208, Juneau.

McBride, D.N., and J.A. Wilcock. 1983. Alaska chinook salmon (*Oncorhynchus tshawytscha* Walbaum) catch and escapement, 1961-1980, with age, size, and sex composition estimates. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 212, Juneau.

McBride, D.N., R.D. Harding, B.A. Cross, and R.H. Conrad. 1985. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the commercial catches from the central district eastside set gill net fishery in upper Cook Inlet, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 251, Juneau.

Merritt, M.F., J.A. Wilcock, and L. K. Brannian. 1988. Origins of chinook salmon in the Yukon River fisheries, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 223, Juneau.

Milligan, P.A., W.O. Rublee, D.D. Cornett, R.A.C. Johnston. 1985. The distribution and abundance of chinook salmon (*Oncorhynchus tshawytscha*) in the upper Yukon River basin as determined by a radio-tagging and spaghetti tagging program: 1982–1983. Canadian Department of Fisheries and Oceans, Canadian Technical Report of Fisheries and Aquatic Sciences 1352.

Mills, M.J. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game, Division of Sport Fish, Federal Aid in Fish Restoration, Annual Performance Report 1982-1983, Project F-9-15, 24, Anchorage.

Mills, M.J. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game, Division of Sport Fish, Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25, Anchorage.

Mills, M.J. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game, Division of sport Fish, Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26, Anchorage.

Mills, M.J. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game, Division of Sport Fish, Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-9-18, 27, Anchorage.

Mills, M.J. 1987. Alaska statewide sport fish harvest studies (1986). Alaska Department of Fish and Game, Division of Sport Fish, Federal Aid in Fish Restoration, Annual Performance Report, 1986-1987, Project F-9-19, 28, Anchorage.

Minard, R.E.1985.Forecasting Nushagak and Togiak district chinook salmon (*Oncorhynchus tshawytscha*) returns using spawner-recruit and sibling return models. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 85-1 (unpublished), Anchorage.

Mundy, P.R. 1982. Migratory timing of adult chinook salmon (*Oncorhynchus tshawytscha*) in the lower Yukon, Alaska with respect to fisheries management. Department of Oceanography, School of Sciences and Health Professions, Old Dominion University, Technical Report 82-1, Norfolk, Virginia.

Mundy, P.R. 1984. Migratory timing of salmon in Alaska with an annotated bibliography on migratory behavior of relevance to fisheries research. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational leaflet 234, Juneau.

Mundy, P.R., J.E. Clark, H. Schaller, and J. Hollowed. 1981a. The Yukon data base, May 1981, volume I: commercial catch, subarea: lower Yukon, species: king salmon (*Oncorhynchus tshawytscha*). Department of Oceanography, School of Sciences and Health Professions, Old Dominion University, Advisory Report Contract 81-334, Norfolk, Virginia.

Mundy, P.R., J.E. Clark, H. Schaller, and J. Hollowed. 1981b. The Yukon data base, May 1981, volume II: test fishing, 1963-1979 Flat Island, Big Eddy, Middle Mouth, subarea: lower Yukon, species: king salmon (*Oncorhynchus tshawytscha*). Department of Oceanography, School of Sciences and Health Professions, Old Dominion University, Advisory Report Contract 81-334, Norfolk, Virginia.

Nelson, M.L. 1985. A report to the Alaska Board of Fisheries November, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 85-8 (unpublished), Anchorage.

Nelson, M.L. 1987. History and management of the Nushagak chinook salmon fishery. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 87-1 (unpublished), Anchorage.

Pearse, P.H. 1982. Turning the tide a new policy for Canada's Pacific fisheries. The Commission on Pacific Fisheries Policy, Final Report, Vancouver, British Columbia.

Ricker, W.E. 1954. Stock and recruitment. Journal of the Fisheries Research Board of Canada 11:559-623.

Rogers, D.E. 1987. Interceptions of Yukon salmon by high seas fisheries. University of Washington, Fisheries Research Institute, School of Fisheries, Final Report, Contract 87-0099, Seattle.

Rogers, D.E., K.W. Myers, C.K. Harris, C.M. Knudsen, R Walker, and N.D. Davis. 1984. Origins of chinook salmon in the area of the Japanese mothership salmon fishery. University of Washington, Fisheries Research Institute, School of Fisheries, Final Report, Contract 84-0152, Seattle.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. Macmillan Publishing Co., Inc., New York.

Van Hyning, J. M. 1973. Stock-recruitment relationships for Columbia River chinook salmon. Pages 98 to 97 *in* B.B. Parrish, editor. Fish stocks and recruitment. Rapports et Proces-verbaux Des Renions Vol. 164.

Walker, C.E. 1976. Studies on the freshwater and anadromous fishes of the Yukon River within Canada. Department of the Environmental Fisheries and Marine Services, Report PAC T/76-7, Vancouver, British Columbia.

Wilcock, J. A. 1984. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 243, Juneau.

Wilcock, J. A. 1985. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 157, Juneau.

Wilcock, J. A. 1986. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 178, Juneau.

Wilcock J. A., and D. N. McBride. 1983. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 226, Juneau.

APPENDIX

Appendix A. Daily and cumulative proportions of total chinook salmon CPUE from the Lower Yukon River test fishery (8.5-in mesh nets), 1982.

Date	Day of	All Stocks		Lower		Middle		Upper	
(1982)	Run	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
07-Jun	7	0.040	0.040	0.008	0.008	0.044	0.044	0.054	0.054
08-Jun	8	0.013	0.053	0.002	0.010	0.014	0.058	0.017	0.071
09-Jun	9	0.002	0.055	0.000	0.011	0.002	0.061	0.003	0.074
10-Jun	10	0.001	0.057	0.000	0.011	0.002	0.063	0.002	0.076
11-Jun	11	0.019	0.076	0.004	0.015	0.021	0.084	0.026	0.102
12-Jun	12	0.023	0.099	0.004	0.019	0.026	0.109	0.031	0.133
13-Jun	13	0.052	0.151	0.010	0.029	0.057	0.166	0.069	0.202
14-Jun	14	0.022	0.174	0.005	0.035	0.027	0.193	0.029	0.230
15-Jun	15	0.016	0.189	0.004	0.038	0.019	0.212	0.020	0.250
16-Jun	16	0.038	0.227	0.014	0.052	0.045	0.257	0.047	0.297
17-Jun	17	0.037	0.264	0.013	0.065	0.043	0.300	0.045	0.342
18-Jun	18	0.026	0.290	0.009	0.075	0.031	0.331	0.032	0.374
19-Jun	19	0.040	0.330	0.013	0.087	0.052	0.383	0.047	0.421
20-Jun	20	0.074	0.404	0.023	0.111	0.097	0.480	0.088	0.509
21-Jun	21	0.084	0.488	0.026	0.137	0.110	0.590	0.100	0.609
22-Jun	22	0.036	0.524	0.011	0.149	0.047	0.637	0.043	0.652
23-Jun	23	0.025	0.548	0.031	0.179	0.018	0.655	0.025	0.676
24-Jun	24	0.043	0.592	0.054	0.233	0.032	0.686	0.044	0.720
25-Jun	25	0.021	0.613	0.026	0.259	0.015	0.702	0.021	0.741
26-Jun	26	0.016	0.628	0.020	0.279	0.016	0.717	0.014	0.755
27-Jun	27	0.036	0.664	0.045	0.324	0.036	0.753	0.031	0.786
28-Jun	28	0.058	0.723	0.074	0.398	0.059	0.812	0.051	0.837
29-Jun	29	0.022	0.745	0.028	0.426	0.023	0.834	0.020	0.856
30-Jun	30	0.037	0.782	0.079	0.505	0.008	0.842	0.029	0.886
01-Jul	31	0.029	0.811	0.062	0.567	0.006	0.848	0.023	0.909
02-Jul	32	0.028	0.839	0.061	0.628	0.006	0.854	0.023	0.932
03-Jul	33	0.021	0.860	0.048	0.677	0.019	0.873	0.009	0.941
04-Jul	34	0.030	0.890	0.069	0.746	0.027	0.900	0.013	0.953
05-Jul	35	0.022	0.912	0.050	0.796	0.020	0.920	0.009	0.963
06-Jul	36	0.009	0.921	0.021	0.817	0.008	0.928	0.004	0.966
07-Jul	37	0.026	0.947	0.061	0.877	0.024	0.952	0.011	0.977
08-Jul	38	0.007	0.954	0.017	0.895	0.007	0.959	0.003	0.981
09-Jul	39	0.006	0.960	0.014	0.908	0.005	0.964	0.003	0.983
10-Jul	40	0.013	0.973	0.029	0.938	0.012	0.976	0.005	0.989
11-Jul	41	0.006	0.979	0.014	0.952	0.005	0.981	0.003	0.991
12-Jul	42	0.011	0.990	0.026	0.978	0.010	0.991	0.005	0.996
13-Jul	43	0.006	0.996	0.014	0.991	0.005	0.997	0.003	0.998
14-Jul	44	0.001	0.998	0.003	0.995	0.001	0.998	0.001	0.999
15-Jul	45	0.002	1.000	0.005	1.000	0.002	1.000	0.001	1.000
Mean		23.3		29.8		21.9		20.8	
Variance		74.5		53.2		69.8		59.5	

Appendix B. Lower Yukon River test fishery proportions of daily chinook salmon CPUE (8.5-in mesh nets) by run of origin in 1982.

Date (1982)	Day of the Run	Region of Origin		
		Lower	Middle	Upper
06-Jun	6	0.048	0.248	0.704
07-Jun	7	0.048	0.248	0.704
08-Jun	8	0.048	0.248	0.704
09-Jun	9	0.048	0.248	0.704
10-Jun	10	0.048	0.248	0.704
11-Jun	11	0.048	0.248	0.704
12-Jun	12	0.048	0.248	0.704
13-Jun	13	0.048	0.248	0.704
14-Jun	14	0.059	0.269	0.671
15-Jun	15	0.059	0.269	0.671
16-Jun	16	0.089	0.267	0.645
17-Jun	17	0.089	0.267	0.645
18-Jun	18	0.089	0.267	0.645
19-Jun	19	0.078	0.295	0.628
20-Jun	20	0.078	0.295	0.628
21-Jun	21	0.078	0.295	0.628
22-Jun	22	0.078	0.295	0.628
23-Jun	23	0.306	0.165	0.529
24-Jun	24	0.306	0.165	0.529
25-Jun	25	0.306	0.165	0.529
26-Jun	26	0.314	0.226	0.460
27-Jun	27	0.314	0.226	0.460
28-Jun	28	0.314	0.226	0.460
29-Jun	29	0.314	0.226	0.460
30-Jun	30	0.530	0.047	0.421
01-Jul	31	0.530	0.047	0.421
02-Jul	32	0.530	0.047	0.421
03-Jul	33	0.572	0.204	0.224
04-Jul	34	0.572	0.204	0.224
05-Jul	35	0.572	0.204	0.224
06-Jul	36	0.572	0.204	0.224
07-Jul	37	0.572	0.204	0.224
08-Jul	38	0.572	0.204	0.224
09-Jul	39	0.572	0.204	0.224
10-Jul	40	0.572	0.204	0.224
11-Jul	41	0.572	0.204	0.224
12-Jul	42	0.572	0.204	0.224
13-Jul	43	0.572	0.204	0.224
14-Jul	44	0.572	0.204	0.224
15-Jul	45	0.572	0.204	0.224

Appendix C. **Daily and cumulative proportions of total chinook salmon CPUE from the Lower Yukon River test fishery (8.5-in mesh nets), 1983.**

Date (1983)	Day of Run	All Stocks Daily	All Stocks Cum.	Lower Daily	Lower Cum.	Middle Daily	Middle Cum.	Upper Daily	Upper Cum.
30-May		0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001
31-May		0.002	0.003	0.000	0.000	0.003	0.004	0.001	0.002
01-Jun	1	0.004	0.007	0.001	0.001	0.006	0.010	0.003	0.006
02-Jun	2	0.012	0.019	0.002	0.003	0.017	0.027	0.010	0.015
03-Jun	3	0.062	0.081	0.009	0.011	0.089	0.117	0.050	0.065
04-Jun	4	0.058	0.140	0.008	0.019	0.083	0.200	0.046	0.111
05-Jun	5	0.070	0.209	0.010	0.029	0.100	0.300	0.056	0.167
06-Jun	6	0.058	0.267	0.008	0.037	0.083	0.382	0.046	0.213
07-Jun	7	0.029	0.296	0.018	0.055	0.028	0.410	0.035	0.248
08-Jun	8	0.050	0.346	0.031	0.087	0.048	0.458	0.061	0.310
09-Jun	9	0.123	0.469	0.077	0.163	0.118	0.576	0.151	0.460
10-Jun	10	0.014	0.484	0.009	0.172	0.014	0.590	0.018	0.478
11-Jun	11	0.023	0.507	0.006	0.179	0.017	0.607	0.039	0.517
12-Jun	12	0.016	0.523	0.004	0.183	0.012	0.619	0.026	0.543
13-Jun	13	0.016	0.539	0.004	0.188	0.012	0.630	0.026	0.569
14-Jun	14	0.004	0.542	0.001	0.189	0.003	0.633	0.006	0.576
15-Jun	15	0.038	0.580	0.015	0.203	0.028	0.661	0.060	0.636
16-Jun	16	0.057	0.637	0.022	0.225	0.043	0.704	0.091	0.726
17-Jun	17	0.034	0.671	0.013	0.239	0.026	0.730	0.055	0.781
18-Jun	18	0.014	0.685	0.023	0.261	0.011	0.741	0.014	0.795
19-Jun	19	0.011	0.696	0.017	0.279	0.009	0.750	0.011	0.806
20-Jun	20	0.036	0.732	0.059	0.337	0.029	0.779	0.035	0.841
21-Jun	21	0.005	0.737	0.008	0.346	0.004	0.783	0.005	0.846
22-Jun	22	0.031	0.767	0.055	0.401	0.029	0.812	0.022	0.868
23-Jun	23	0.018	0.785	0.032	0.432	0.017	0.829	0.013	0.881
24-Jun	24	0.006	0.791	0.010	0.442	0.005	0.834	0.004	0.885
25-Jun	25	0.007	0.798	0.013	0.456	0.007	0.841	0.005	0.890
26-Jun	26	0.012	0.810	0.022	0.477	0.012	0.853	0.009	0.898
27-Jun	27	0.011	0.821	0.020	0.497	0.011	0.864	0.008	0.906
28-Jun	28	0.005	0.826	0.008	0.506	0.004	0.868	0.003	0.910
29-Jun	29	0.025	0.851	0.071	0.577	0.019	0.887	0.013	0.923
30-Jun	30	0.034	0.886	0.098	0.675	0.026	0.913	0.018	0.941
01-Jul	31	0.006	0.892	0.017	0.692	0.005	0.918	0.003	0.944
02-Jul	32	0.013	0.904	0.036	0.728	0.010	0.927	0.007	0.950
03-Jul	33	0.029	0.933	0.082	0.810	0.022	0.949	0.015	0.965
04-Jul	34	0.013	0.947	0.038	0.848	0.010	0.959	0.007	0.972
05-Jul	35	0.003	0.949	0.008	0.856	0.002	0.962	0.001	0.974
06-Jul	36	0.008	0.958	0.024	0.880	0.006	0.968	0.004	0.978
07-Jul	37	0.006	0.963	0.016	0.896	0.004	0.972	0.003	0.981
08-Jul	38	0.002	0.966	0.007	0.902	0.002	0.974	0.001	0.982
09-Jul	39	0.004	0.969	0.011	0.913	0.003	0.977	0.002	0.984
10-Jul	40	0.003	0.972	0.008	0.921	0.002	0.979	0.001	0.986
11-Jul	41	0.011	0.983	0.030	0.951	0.008	0.987	0.006	0.991
12-Jul	42	0.006	0.988	0.016	0.967	0.004	0.991	0.003	0.994
13-Jul	43	0.005	0.993	0.015	0.981	0.004	0.995	0.003	0.997
14-Jul	44	0.003	0.996	0.008	0.989	0.002	0.997	0.001	0.998
15-Jul	45	0.004	1.000	0.011	1.000	0.003	1.000	0.002	1.000
Mean		15.1		25.0		13.0		13.5	
Variance		115.8		113.1		108.3		75.9	

Appendix D. Lower Yukon River test fishery proportions of daily chinook salmon CPUE (8.5-in mesh nets) by run of origin in 1983.

Date (1983)	Day of the Run	Region of Origin Lower	Middle	Upper
30-May		0.022	0.691	0.287
31-May		0.022	0.691	0.287
01-Jun	1	0.022	0.691	0.287
02-Jun	2	0.022	0.691	0.287
03-Jun	3	0.022	0.691	0.287
04-Jun	4	0.022	0.691	0.287
05-Jun	5	0.022	0.691	0.287
06-Jun	6	0.022	0.691	0.287
07-Jun	7	0.098	0.461	0.440
08-Jun	8	0.098	0.461	0.440
09-Jun	9	0.098	0.461	0.440
10-Jun	10	0.098	0.461	0.440
11-Jun	11	0.044	0.357	0.600
12-Jun	12	0.044	0.357	0.600
13-Jun	13	0.044	0.357	0.600
14-Jun	14	0.044	0.357	0.600
15-Jun	15	0.061	0.363	0.576
16-Jun	16	0.061	0.363	0.576
17-Jun	17	0.061	0.363	0.576
18-Jun	18	0.257	0.387	0.356
19-Jun	19	0.257	0.387	0.356
20-Jun	20	0.257	0.387	0.356
21-Jun	21	0.257	0.387	0.356
22-Jun	22	0.282	0.462	0.256
23-Jun	23	0.282	0.462	0.256
24-Jun	24	0.282	0.462	0.256
25-Jun	25	0.282	0.462	0.256
26-Jun	26	0.282	0.462	0.256
27-Jun	27	0.282	0.462	0.256
28-Jun	28	0.282	0.462	0.256
29-Jun	29	0.448	0.365	0.187
30-Jun	30	0.448	0.365	0.187
01-Jul	31	0.448	0.365	0.187
02-Jul	32	0.448	0.365	0.187
03-Jul	33	0.448	0.365	0.187
04-Jul	34	0.448	0.365	0.187
05-Jul	35	0.448	0.365	0.187
06-Jul	36	0.448	0.365	0.187
07-Jul	37	0.448	0.365	0.187
08-Jul	38	0.448	0.365	0.187
09-Jul	39	0.448	0.365	0.187
10-Jul	40	0.448	0.365	0.187
11-Jul	41	0.448	0.365	0.187
12-Jul	42	0.448	0.365	0.187
13-Jul	43	0.448	0.365	0.187
14-Jul	44	0.448	0.365	0.187
15-Jul	45	0.448	0.365	0.187

Appendix E. Lower Yukon River test fishery proportions of daily chinook salmon CPUE (8.5-in mesh nets) by run of origin in 1984.

Date (1984)	Day of the Run	Region of Origin Lower	Middle	Upper
06-Jun	6	0.352	0.518	0.130
07-Jun	7	0.352	0.518	0.130
08-Jun	8	0.352	0.518	0.130
09-Jun	9	0.352	0.518	0.130
10-Jun	10	0.352	0.518	0.130
11-Jun	11	0.352	0.518	0.130
12-Jun	12	0.352	0.518	0.130
13-Jun	13	0.352	0.518	0.130
14-Jun	14	0.352	0.518	0.130
15-Jun	15	0.350	0.529	0.120
16-Jun	16	0.350	0.529	0.120
17-Jun	17	0.350	0.529	0.120
18-Jun	18	0.190	0.580	0.230
19-Jun	19	0.190	0.580	0.230
20-Jun	20	0.366	0.550	0.084
21-Jun	21	0.366	0.550	0.084
22-Jun	22	0.366	0.550	0.084
23-Jun	23	0.477	0.230	0.293
24-Jun	24	0.477	0.230	0.293
25-Jun	25	0.477	0.230	0.293
26-Jun	26	0.477	0.230	0.293
27-Jun	27	0.602	0.307	0.091
28-Jun	28	0.602	0.307	0.091
29-Jun	29	0.640	0.294	0.067
30-Jun	30	0.653	0.189	0.158
01-Jul	31	0.653	0.189	0.158
02-Jul	32	0.653	0.189	0.158
03-Jul	33	0.653	0.189	0.158
04-Jul	34	0.653	0.189	0.158
05-Jul	35	0.653	0.189	0.158
06-Jul	36	0.653	0.189	0.158
07-Jul	37	0.653	0.189	0.158
08-Jul	38	0.653	0.189	0.158
09-Jul	39	0.653	0.189	0.158
10-Jul	40	0.653	0.189	0.158
11-Jul	41	0.653	0.189	0.158
12-Jul	42	0.653	0.189	0.158
13-Jul	43	0.653	0.189	0.158
14-Jul	44	0.653	0.189	0.158
15-Jul	45	0.653	0.189	0.158

Appendix F. Daily and cumulative proportions of total chinook salmon CPUE from the Lower Yukon River test fishery (8.5-in mesh nets), 1984.

Date (1984)	Day of Run	All Stocks Daily	All Stocks Cum.	Lower Daily	Lower Cum.	Middle Daily	Middle Cum.	Upper Daily	Upper Cum.
08-Jun	8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
09-Jun	9	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001
10-Jun	10	0.000	0.001	0.000	0.001	0.001	0.002	0.000	0.001
11-Jun	11	0.001	0.002	0.001	0.002	0.001	0.003	0.001	0.002
12-Jun	12	0.020	0.022	0.015	0.017	0.027	0.031	0.016	0.018
13-Jun	13	0.038	0.060	0.029	0.045	0.053	0.083	0.031	0.048
14-Jun	14	0.047	0.107	0.035	0.080	0.065	0.148	0.038	0.086
15-Jun	15	0.065	0.171	0.048	0.129	0.092	0.240	0.048	0.134
16-Jun	16	0.027	0.199	0.021	0.149	0.039	0.279	0.021	0.155
17-Jun	17	0.041	0.240	0.031	0.180	0.058	0.337	0.031	0.186
18-Jun	18	0.030	0.269	0.012	0.192	0.046	0.383	0.043	0.228
19-Jun	19	0.005	0.275	0.002	0.195	0.009	0.392	0.008	0.236
20-Jun	20	0.059	0.334	0.046	0.241	0.087	0.479	0.031	0.267
21-Jun	21	0.110	0.444	0.086	0.327	0.162	0.641	0.057	0.324
22-Jun	22	0.015	0.459	0.012	0.339	0.022	0.663	0.008	0.332
23-Jun	23	0.079	0.538	0.081	0.420	0.049	0.712	0.144	0.477
24-Jun	24	0.080	0.618	0.081	0.501	0.049	0.761	0.145	0.622
25-Jun	25	0.054	0.672	0.056	0.557	0.034	0.795	0.099	0.721
26-Jun	26	0.009	0.681	0.009	0.566	0.005	0.800	0.016	0.737
27-Jun	27	0.070	0.751	0.091	0.657	0.058	0.858	0.040	0.777
28-Jun	28	0.044	0.796	0.057	0.714	0.037	0.895	0.025	0.802
29-Jun	29	0.005	0.801	0.007	0.721	0.004	0.899	0.002	0.804
30-Jun	30	0.006	0.807	0.009	0.730	0.003	0.902	0.006	0.810
01-Jul	31	0.010	0.817	0.014	0.744	0.005	0.907	0.010	0.820
02-Jul	32	0.030	0.847	0.042	0.786	0.015	0.922	0.029	0.849
03-Jul	33	0.011	0.858	0.016	0.802	0.006	0.928	0.011	0.861
04-Jul	34	0.034	0.892	0.048	0.850	0.017	0.945	0.034	0.894
05-Jul	35	0.043	0.936	0.061	0.910	0.022	0.967	0.043	0.937
06-Jul	36	0.013	0.949	0.019	0.929	0.007	0.974	0.013	0.950
07-Jul	37	0.022	0.971	0.030	0.959	0.011	0.985	0.021	0.971
08-Jul	38	0.010	0.980	0.013	0.972	0.005	0.990	0.009	0.981
09-Jul	39	0.008	0.988	0.011	0.983	0.004	0.994	0.008	0.988
10-Jul	40	0.001	0.989	0.001	0.985	0.000	0.994	0.001	0.989
11-Jul	41	0.004	0.993	0.006	0.990	0.002	0.997	0.004	0.993
12-Jul	42	0.001	0.994	0.001	0.992	0.000	0.997	0.001	0.994
13-Jul	43	0.003	0.997	0.004	0.996	0.001	0.998	0.003	0.997
14-Jul	44	0.003	1.000	0.004	0.999	0.001	1.000	0.003	1.000
15-Jul	45	0.000	1.000	0.001	1.000	0.000	1.000	0.000	1.000
Mean		23.5		25.3		21.1		24.0	
Variance		51.6		54.1		40.9		45.8	

Appendix G. Daily and cumulative proportions of total chinook salmon CPUE from the Lower Yukon River test fishery (8.5-in mesh nets), 1985.

Date	Day of	All Stocks		Lower		Middle		Upper	
(1985)	Run	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
16-Jun	16	0.002	0.002	0.001	0.001	0.002	0.002	0.002	0.002
17-Jun	17	0.002	0.003	0.001	0.002	0.002	0.005	0.002	0.004
18-Jun	18	0.013	0.016	0.008	0.011	0.019	0.024	0.016	0.020
19-Jun	19	0.008	0.024	0.006	0.016	0.012	0.036	0.010	0.031
20-Jun	20	0.019	0.043	0.013	0.029	0.029	0.065	0.024	0.055
21-Jun	21	0.038	0.082	0.026	0.055	0.058	0.123	0.049	0.104
22-Jun	22	0.045	0.126	0.030	0.085	0.068	0.190	0.057	0.161
23-Jun	23	0.030	0.156	0.020	0.105	0.044	0.235	0.038	0.199
24-Jun	24	0.061	0.217	0.048	0.153	0.100	0.335	0.066	0.265
25-Jun	25	0.031	0.247	0.024	0.177	0.051	0.386	0.033	0.298
26-Jun	26	0.021	0.269	0.015	0.192	0.066	0.452	0.017	0.315
27-Jun	27	0.095	0.364	0.067	0.259	0.295	0.747	0.076	0.391
28-Jun	28	0.039	0.403	0.027	0.286	0.120	0.867	0.031	0.422
29-Jun	29	0.074	0.477	0.076	0.363	0.046	0.913	0.080	0.502
30-Jun	30	0.057	0.535	0.059	0.422	0.036	0.949	0.062	0.564
01-Jul	31	0.049	0.583	0.050	0.472	0.030	0.979	0.052	0.616
02-Jul	32	0.033	0.617	0.034	0.506	0.021	1.000	0.036	0.652
03-Jul	33	0.054	0.671	0.070	0.576	0.000	1.000	0.049	0.701
04-Jul	34	0.047	0.718	0.060	0.636	0.000	1.00	0.042	0.743
05-Jul	35	0.021	0.738	0.027	0.662	0.000	1.000	0.019	0.762
06-Jul	36	0.014	0.752	0.018	0.680	0.000	1.000	0.012	0.775
07-Jul	37	0.042	0.794	0.054	0.734	0.000	1.000	0.038	0.812
08-Jul	38	0.084	0.877	0.108	0.842	0.000	1.000	0.076	0.889
09-Jul	39	0.048	0.925	0.061	0.903	0.000	1.000	0.043	0.932
10-Jul	40	0.021	0.946	0.027	0.930	0.000	1.000	0.019	0.951
11-Jul	41	0.023	0.969	0.030	0.960	0.000	1.000	0.021	0.972
12-Jul	42	0.009	0.978	0.011	0.971	0.000	1.000	0.008	0.980
13-Jul	43	0.013	0.990	0.016	0.987	0.000	1.000	0.011	0.991
14-Jul	44	0.010	1.000	0.013	1.000	0.000	1.000	0.009	1.000
15-Jul	45	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
Mean		30.5		32.0		25.7		29.9	
Variance		40.8		38.7		9.8		42.3	

Appendix H. Lower Yukon River test fishery proportions of daily chinook salmon CPUE (8.5-in mesh nets) by run of origin in 1985.

Date (1985)	Day of the Run	Region of Origin		
		Lower	Middle	Upper
16-Jun	16	0.333	0.162	0.504
17-Jun	17	0.333	0.162	0.504
18-Jun	18	0.333	0.162	0.504
19-Jun	19	0.333	0.162	0.504
20-Jun	20	0.333	0.162	0.504
21-Jun	21	0.333	0.162	0.504
22-Jun	22	0.333	0.162	0.504
23-Jun	23	0.333	0.162	0.504
24-Jun	24	0.390	0.178	0.432
25-Jun	25	0.390	0.178	0.432
26-Jun	26	0.350	0.335	0.315
27-Jun	27	0.350	0.335	0.315
28-Jun	28	0.350	0.335	0.315
29-Jun	29	0.508	0.067	0.425
30-Jun	30	0.508	0.067	0.425
01-Jul	31	0.508	0.067	0.425
02-Jul	32	0.508	0.067	0.425
03-Jul	33	0.640	0.000	0.360
04-Jul	34	0.640	0.000	0.360
05-Jul	35	0.640	0.000	0.360
06-Jul	36	0.640	0.000	0.360
07-Jul	37	0.640	0.000	0.360
08-Jul	38	0.640	0.000	0.360
09-Jul	39	0.640	0.000	0.360
10-Jul	40	0.640	0.000	0.360
11-Jul	41	0.640	0.000	0.360
12-Jul	42	0.640	0.000	0.360
13-Jul	43	0.640	0.000	0.360
14-Jul	44	0.640	0.000	0.360
15-Jul	45	0.640	0.000	0.360

Appendix I. **Daily and cumulative proportions of total chinook salmon CPUE from the Lower Yukon River test fishery (8.5-in mesh nets), 1986.**

Date (1986)	Day of Run	All Stocks Daily	All Stocks Cum.	Lower Daily	Lower Cum.	Middle Daily	Middle Cum.	Upper Daily	Upper Cum.
08-Jun	8	0.002	0.002	0.001	0.001	0.001	0.001	0.003	0.003
09-Jun	9	0.005	0.008	0.002	0.003	0.004	0.005	0.007	0.010
10-Jun	10	0.003	0.011	0.001	0.004	0.002	0.007	0.004	0.014
11-Jun	11	0.005	0.016	0.002	0.006	0.003	0.010	0.007	0.021
12-Jun	12	0.017	0.033	0.007	0.013	0.011	0.022	0.022	0.043
13-Jun	13	0.014	0.046	0.005	0.018	0.009	0.031	0.018	0.061
14-Jun	14	0.020	0.066	0.007	0.025	0.003	0.034	0.027	0.088
15-Jun	15	0.047	0.113	0.016	0.042	0.007	0.041	0.063	0.151
16-Jun	16	0.030	0.143	0.010	0.052	0.005	0.046	0.040	0.191
17-Jun	17	0.052	0.195	0.018	0.070	0.008	0.054	0.070	0.260
18-Jun	18	0.114	0.309	0.120	0.191	0.000	0.054	0.115	0.375
19-Jun	19	0.110	0.419	0.116	0.307	0.000	0.054	0.110	0.485
20-Jun	20	0.017	0.436	0.018	0.325	0.000	0.054	0.017	0.502
21-Jun	21	0.076	0.512	0.080	0.405	0.000	0.054	0.075	0.577
22-Jun	22	0.041	0.553	0.031	0.436	0.398	0.452	0.036	0.613
23-Jun	23	0.037	0.590	0.028	0.464	0.367	0.819	0.033	0.647
24-Jun	24	0.018	0.608	0.014	0.478	0.181	1.000	0.016	0.663
25-Jun	25	0.070	0.678	0.082	0.560	0.000	1.000	0.066	0.729
26-Jun	26	0.107	0.785	0.126	0.686	0.000	1.000	0.101	0.829
27-Jun	27	0.047	0.833	0.056	0.741	0.000	1.000	0.044	0.874
28-Jun	28	0.020	0.853	0.029	0.771	0.000	1.000	0.016	0.890
29-Jun	29	0.017	0.870	0.025	0.796	0.000	1.000	0.013	0.903
30-Jun	30	0.004	0.874	0.006	0.802	0.000	1.000	0.003	0.906
01-Jul	31	0.019	0.893	0.023	0.825	0.000	1.000	0.018	0.924
02-Jul	32	0.027	0.920	0.032	0.857	0.000	1.000	0.025	0.949
03-Jul	33	0.020	0.940	0.041	0.899	0.000	1.000	0.010	0.958
04-Jul	34	0.006	0.945	0.012	0.911	0.000	1.000	0.003	0.961
05-Jul	35	0.004	0.950	0.008	0.919	0.000	1.000	0.002	0.963
06-Jul	36	0.009	0.959	0.019	0.938	0.000	1.000	0.004	0.968
07-Jul	37	0.005	0.963	0.007	0.945	0.000	1.000	0.004	0.971
08-Jul	38	0.005	0.968	0.007	0.951	0.000	1.000	0.004	0.975
09-Jul	39	0.012	0.980	0.018	0.970	0.000	1.000	0.009	0.984
10-Jul	40	0.003	0.982	0.004	0.974	0.000	1.000	0.002	0.986
11-Jul	41	0.001	0.984	0.002	0.976	0.000	1.000	0.001	0.987
12-Jul	42	0.005	0.989	0.007	0.983	0.000	1.000	0.004	0.991
13-Jul	43	0.005	0.994	0.007	0.991	0.000	1.000	0.004	0.995
14-Jul	44	0.005	0.999	0.007	0.998	0.000	1.000	0.004	0.999
15-Jul	45	0.001	1.000	0.002	1.000	0.000	1.000	0.001	1.000
Mean		22.6		24.7		22.3		21.6	
Variance		43.5		45.4		5.4		40.3	

Appendix J. Lower Yukon River test fishery proportions of daily chinook salmon CPUE (8.5-in mesh nets) by run of origin in 1986.

Date (1986)	Day of the Run	Region of Origin Lower	Middle	Upper
08-Jun	8	0.128	0.012	.861
09-Jun	9	0.128	0.012	0.861
10-Jun	10	0.128	0.012	0.861
11-Jun	11	0.128	0.012	0.861
12-Jun	12	0.128	0.012	0.861
13-Jun	13	0.128	0.012	0.861
14-Jun	14	0.115	0.003	0.883
15-Jun	15	0.115	0.003	0.883
16-Jun	16	0.115	0.003	0.883
17-Jun	17	0.115	0.003	0.883
18-Jun	18	0.343	0.000	0.658
19-Jun	19	0.345	0.000	0.655
20-Jun	20	0.345	0.000	0.655
21-Jun	21	0.345	0.000	0.655
22-Jun	22	0.246	0.172	0.583
23-Jun	23	0.246	0.172	0.583
24-Jun	24	0.246	0.172	0.583
25-Jun	25	0.383	0.000	0.617
26-Jun	26	0.383	0.000	0.617
27-Jun	27	0.383	0.000	0.617
28-Jun	28	0.485	0.000	0.516
29-Jun	29	0.485	0.000	0.516
30-Jun	30	0.485	0.000	0.516
01-Jul	31	0.394	0.000	0.607
02-Jul	32	0.390	0.000	0.610
03-Jul	33	0.680	0.000	0.320
04-Jul	34	0.680	0.000	0.320
05-Jul	35	0.680	0.000	0.320
06-Jul	36	0.680	0.000	0.320
07-Jul	37	0.488	0.000	0.512
08-Jul	38	0.488	0.000	0.512
09-Jul	39	0.488	0.000	0.512
10-Jul	40	0.488	0.000	0.512
11-Jul	41	0.488	0.000	0.512
12-Jul	42	0.488	0.000	0.512
13-Jul	43	0.488	0.000	0.512
14-Jul	44	0.488	0.000	0.512
15-Jul	45	0.488	0.000	0.512