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1984 NEWHALEN RIVER ADULT SALMON ENUMERATION PROGRAM

by

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1.0 ABSTRACT

The escapement of sockeye salmon to spawning areas of the Newhalen River-Lake Clark system above RM 22 was estimated by a systematic visual enumeration program for the fifth consecutive year. The escapement estimate of 3.1 million, which represents 29.5 percent of the 1984 Kvichak River system escapement of 10.5 million, was the largest counted escapement at RM 22 since our observations began in 1980. A limited index counting program was also conducted at RM 1. After 7 days of counting at RM 1 a projected total escapement estimate of 3.5 million was made. This estimate compared closely to the total escapement estimate of 3.8 million to the Newhalen River-Lake Clark system based on the RM 22 escapement enumeration program together with spawning ground counts of spawners below RM 22. Results from the 1984 Newhalen River escapement studies are compared to previous years and the recent production of the Newhalen River-Lake Clark system is examined.

KEY WORDS: Sockeye salmon, Newhalen River-Lake Clark system, Kvichak River system, escapement estimation, escapement timing.

2.0 ACKNOWLEDGMENTS

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3.0 INTRODUCTION

Observations on sockeye salmon runs to the Kvichak River system of Bristol Bay in southwestern Alaska have been made for more than sixty years. This system is the largest producer of sockeye salmon in Alaska and also one of the most variable producers with annual runs since 1950 ranging from 300,000 to 42 million. Harvest of the sockeye salmon returns to the Kvichak River system is regulated by controlling the total size of the escapement which ascends the Kvichak River. Escapement goals are established before the fishing season and the manager's task is to secure the right number of spawners. A further improvement is to provide sufficient escapement to each component lake system, as often the distribution of spawners on the spawning grounds is even more important than the actual size of the escapement.

The Fisheries Research Institute (FRI) has studied the sockeye salmon runs to the Kvichak River system since 1948 to formulate escapement sequences, not only for the Kvichak system as a whole, but for individual component lake systems. Since 1979 a major part of our research has been a study of the sockeye salmon runs of the Newhalen River-Lake Clark system, an important component of the Kvichak River system (Figure 1). This system was probably overfished in the past and ceased to be a major contributor to Kvichak salmon production in the 1930's (1). Recently it has again become a major contributor to the production of sockeye salmon in the Kvichak system (2) because environmental conditions were particularly favorable to salmon survival and there was a lack of, or reduced, early season commercial harvest by the Bristol Bay fishery which favors escapement of some stocks of the Lake

Clark component. We have studied escapement sizes and the life history of juvenile salmon and the abundance of fry produced in this system in order to define a rational escapement sequence (3).

Beginning in 1981, research activities in the Newhalen River-Lake Clark system received added impetus from exploratory hydroelectric feasibility studies conducted by the Alaska Power Authority (APA) in the Newhalen and Tazimina Rivers. The Newhalen River interconnects Iliamna Lake with Lake Clark, the two principal spawning and rearing areas of sockeye salmon in the Kvichak River system. It serves as a passageway for sockeye salmon of the Newhalen River-Lake Clark system. Both the adult salmon en route to the spawning grounds, and the juvenile salmon moving downstream to rear in Iliamna Lake for part of their freshwater life, or the ocean, travel the thirty-mile stretch of river. The same waters, specifically at Newhalen River Mile 7 (RM 7), are currently under consideration by the Alaska Power Authority (APA) as a potential run-of-the-river regional hydroelectric site in the Bristol Bay Regional Power Plan. This report summarizes the APA supported adult salmon enumeration programs conducted in the Newhalen River in 1984 and compares the results to past observations.

4.0 MATERIALS AND METHODS

4.1 Estimate of Absolute Sockeye Salmon Escapement to Upper Newhalen River

4.1.1 Location and Method of Observation

We estimated the 1984 escapement to spawning areas above Newhalen River Mile (RM) 22.3 (generalized as RM 22) by tower enumeration (intermittent visual counts of ascending salmon) as we had done from 1980 through 1983 (4-7). The enumeration station was located at the site established in 1980 (Figure 2). Visual counts were made from locations standardized in 1981; one tree on the right (west) bank and one tree on the left (east) bank. Counts were made over the period July 1 through August 22.

In 1984 migration intensities were the highest we have observed at RM 22 and the counting procedure varied with the intensity of the migration. Generally, fish were tallied singly with hand tallies. During periods when the number passing was greater than 200 per minute, they were tallied in groups of 5. Polaroid glasses were worn to reduce surface and sun glare, and audible timers were used for precise counting periods.

As in 1980-1983, the basic sample unit consisted of 10-minute counts made systematically each hour from each bank on a 20-hour/day basis (0400-2400h). A 24-hour counting scheme was conducted for 5 days during the course of the run to obtain further information on the daily passage that occcurs during the night period 0000-0400h. During the hours of darkness, 12-volt spotlights aimed slightly offshore and

upstream were used to produce an almost flat beam of light. Fish were counted as they passed through the dimly lit area of the light beam focus.

4.1.2 Estimators of Daily Escapement

The 10-minute counts were multiplied by six to obtain hourly estimates of passage rates. Whenever systematic counts ceased at night or during daylight periods due to lack of personnel, turbid water, or other inclement weather conditions that precluded obtaining representative counts, estimates were made for the time periods missed. A regression equation relating 20-hour to 24-hour counts, based on all years of observation at RM 22, was used to estimate passage during the night period (0000-0400h). For other periods of no observation, the mean proportion of the daily passage that each hour, or each 4-hour block of hours represented, as determined from either past relationships, or days of 24-hour counting, was used rather than a straight linear interpolation which does not adjust for periodicity in patterns of ascent. However, the latter approach was adopted for interpolation of 10-minute counts at the beginning of the run and between sample counts conducted on the every-other-hour basis using the following basic formula:

$$\frac{C_2 - C_1}{n + 1} = \pm \Delta$$

where C_1 = first count or average of x number of counts after period(s) missed

C_2 = last count or average of a number of adjacent counts before interpolation period

n = number of hours without counts

Δ = positive or negative change in C_1.

4.2 Timing and Relative Magnitude of Escapement to the Newhalen River System

The relative magnitude and the proportion of the Kvichak system escapement at Igiugig that is bound for the Newhalen River-Lake Clark system can be estimated from a few days of index counting near the mouth of the Newhalen River (8). Since there was concern that a major portion of the 1984 run to the Kvichak system may have been bound for the Newhalen River-Lake Clark area and that a large escapement, e.g., 10 million, might be wasteful in the case that crowding on the spawning grounds might result in lower returns than would be realized from a lower escapement level, we conducted an index counting program in the lower Newhalen River for a short period in 1984.

4.2.1 Method of Observation

Visual counts were made daily from a 30 ft bluff on the left (east) bank of the Newhalen River at RM .75 (generalized as RM 1) just upriver from the City of Newhalen (Figure 1) from 0800-1700h (10-hour index) over the period June 28 through July 13. Limited personnel prevented maintaining the index program for a longer period.

4.3 Climatological and Hydrological Observations

Climatological observations, water temperature, river stage elevation, and turbidity were recorded daily at RM 22. Infrequent readings of river stage elevation were also made at the U.S. Geological Survey gauging station at RM 16 and once at RM 6.5, where a staff gauge had been placed on 29 May 1982 during the spring Dames and Moore juvenile

salmon program (9). These observations were made to obtain further information on river discharge rates and how they may relate to delays and velocity barriers to the upstream passage of adult sockeye salmon in the Newhalen River.

5.0 RESULTS

5.1 Estimate of Absolute Escapement Past RM 22

A systematic escapement enumeration program for the Newhalen River-Lake Clark system has only been conducted over the last 6 years, 1979-1984. In 1979 and 1980, enumeration programs were conducted at Newhalen RM .75 (generalized as RM 1), where ranges rather than single point estimates of escapement were necessary because of problems in discounting washbacks from total counts (3 and 4). In 1980 an enumeration program was also conducted at Newhalen RM 22 in an attempt to obtain a better estimate of escapement. However, due to extremely high watershed runoff, a prolonged velocity block to salmon passage occurred in the Newhalen River rapids between RM 2 and RM 7 which prevented a large, but not well-known, portion of the Newhalen River-Lake Clark system salmon return from reaching their spawning grounds (4, 5, and 10). The estimated Newhalen River escapement ranges at RM 1 in 1979 and 1980 were 7.4-10.2 million and 4.6-9.6 million, respectively. Estimates of escapement to spawning areas above RM 22 in 1980 and 1981 were 1.5 million and 232,000, respectively, and represented 6.7 percent and 13.2 percent of the total Kvichak system escapement, respectively. In 1982 and 1983 the counted escapements past RM 22 were 147,000 and 703,000, respectively, and represented 13.0 percent and 19.7 percent of the total Kvichak system escapement, respectively.

The five days of 24-hour counting conducted during the 1984 Newhalen RM 22 enumeration showed a range of 1.5 to 5.6 percent of the daily passage occurring during the night period (0000-0004h). Examination of data from all years of counting at RM 22 (Appendix Table A1)

showed a trend for a lower proportion of daily passage to occur during the night period as the daily passage rate increased. Since most of the night counts in 1984 were conducted during periods of high daily passage rates, we decided to use data selected from all years of observation (Appendix Table A2) to determine a factor for expanding 20-hour counts to 24-hour daily estimates of escapement in 1984. The data from all years were grouped into five ranges of daily passage rates and regression analysis was performed (Table 1). The regression equation relating 20-hour to 24-hour counts was then used to expand 20-hour counts to 24-hour daily estimates of escapement. Comparison of daily sockeye salmon escapement estimates based on 20-hour and 24-hour counts showed the 20-hour/day counting program accounted for 96.4 percent of the total estimated escapement at RM 22 in 1984 (Table 2).

The daily escapement estimates at RM 22 are summarized and compared with the results of the 1984 ADF&G Igiugig tower enumeration program in Table 3. The 1984 Newhalen River escapement estimate of 3.1 million above RM 22 was 29.5 percent of the Kvichak River system escapement of 10.5 million, enumerated by ADF&G at Igiugig. This is the largest counted escapement at RM 22 since the program was initiated there in 1980.

5.2 Index of Escapement RM 1

The projected magnitude of the 1984 escapement to the Newhalen River-Lake Clark system after seven days of index counting at RM 1 was 3.5 million. This compares closely to the estimated 3.8 million total escapement to the system obtained by adding the aerial survey estimate of sockeye salmon spawning below the Newhalen RM 22 counting station to

the escapement counted past RM 22. The daily 10-hour indices of escapement at RM 1 are summarized and compared with the results of the Kvichak River Igiugig tower enumeration program in Table 4.

5.3 Timing and Pattern of Escapement

5.3.1 Kvichak River

The estimated timing of the 1982 Kvichak run referenced at the head of the Kvichak River (outlet of Iliamna Lake) is shown in Figure 3. The estimated daily catches of Kvichak sockeye salmon were calculated as a fixed portion (.8633) of the daily Naknek-Kvichak District catches and forward-lagged 6 days before they were added to the daily Igiugig escapement. The reconstructed 1984 Kvichak run appears multimodal with the escapement being trimodal and coming primarily from early and middle portions of the run, while the catch came mainly from the middle and late portions of the run.

5.3.2 Newhalen River

The Kvichak River pattern of escapement is compared to the Kvichak run curve, the early run part of the Newhalen River escapement curve at RM 1 and the Newhalen RM 22 escapement curve in Figure 4. While the Kvichak River escapement pattern is trimodal, the RM 22 escapement curve is primarily bimodal. The escapement curve at RM 1 is incomplete, as it only goes to July 13. The escapement pattern at both RM 1 and RM 22 seem to indicate that the Newhalen River system received contributions to escapement from all the major segments of the Kvichak escapement.

The travel time from Igiugig to the Newhalen RM 1 and RM 22 enumeration sites can be examined in Figure 4 and Tables 3 and 4. Generally

the timing of the early escapement pattern at the RM 1 index site lagged back two days corresponds closely to the Iguigig escapement pattern. The straight line distance from Igiugig to the Newhalen River is approximately 50 miles (11), and since salmon can travel more than 20 miles a day through a lake, a lag time of 2 days is reasonable. Comparison of the Newhalen RM 22 escapement curve to the escapement pattern at Igiugig, while indicating approximately a 5-day lag at the beginning, generally does not show much similarity. A major run occurred after August 1 at RM 22 that does not seem to correspond to any late run peak at Igiugig. A reasonable explanation for this seems to be that a major portion of the 1984 salmon return to the Newhalen River system, after entering the river, remained for some time before moving upstream past the RM 22 counting station.

Comparison of the Newhalen RM 1 escapement curve to the escapement pattern at RM 22 (Figure 4 and Tables 3 and 4) generally indicates a 2-day lag through July 13, after which we have no further escapement index information for RM 1.

5.4 Environmental and Hydrological Observations

Climatological and hydrological observations and data summaries that pertain mostly to the Newhalen RM 22 site are presented in Table 5. The Newhalen River remained clear with excellent visibility until July 30, after which it became and remained lightly clouded and occasionally moderately clouded through the duration of the counting program. The 1984 escapement curve at RM 22 is shown together with the discharge pattern of the Newhalen River during the period of upstream salmon migration in Figure 5. Peak summer flows in 1984 were below 20,000 cfs and

were the second lowest we have observed at the Newhalen RM 22 enumeration station since our program began in 1980. Precipitation and watershed runoff, as referenced to Iliamna Lake level, remained below average for the third consecutive year (Figure 6).

The information on the relationship between river stage at RM 16 and RM 22 are shown in Figure 7. Data used to derive the linear relationship are contained in Appendix Tables B1 and B2. All standardized water stage elevation and discharge information from FRI and Dames and Moore studies conducted at RM 22 from 1980-1984 are contained in Appendix Table B3. Generally under conditions of high flows, the river stage at RM 22 increases faster than at RM 16, whereas the opposite is true concerning low-to-moderate flows.

A trip was made on foot to RM 6.5 (Figure 8) on 4 August 1984 to observe the large schools of adult salmon that were concentrated in and between the major areas of rapids and to take readings on the staff gauge placed there in May of 1982. Several 10-minute counts were also made just upstream of the major rapids from the left (east) bank at RM 7. Salmon upstream passage rates were similar to those observed at RM 22 for the same time of day (e.g., approximately 3,000 fish/hour).

The information concerning measurements and changes of river stage elevation at RM 6.5 and RM 16 are summarized in Appendix Table B4. The relationship of changes in relative river stage elevation at RM 6.5 as compared to RM 16 is shown in Figure 9. At RM 6.5, water velocity and river stage are most affected by changes in river discharge, while at RM 16 increases in discharge are mostly reflected in changes in stream

width and velocity, and less in increases in river stages. At low-to-moderate flows, RM 16 is not at bank-full condition, whereas RM 6.5 is nearly always at bank-full condition, except at very low flows. Under conditions of very high flows, almost equal incremental changes in river stage elevation at both locations is indicated. Thus, at lower-to-moderate flows, the relationship between river stage elevation at RM 6.5 and RM 16 is best described by a curvilinear relationship, whereas under conditions of extreme high flows, the relationship between river stage elevation at RM 6.5 and RM 16 is best described by a linear relationship. It is important to continue to obtain information about hydrological conditions and salmon passage at RM 6.5 because of the prolonged velocity block to salmon passage that occurred there in 1980 (4, 5 and 10).

6.0 DISCUSSION

6.1 Salmon Returns to the Newhalen River-Lake Clark System

The rate of sockeye salmon migration through the Newhalen River is affected by flow conditions in a series of rapids and waterfalls from RM 2 through RM 6.5. Delays in the upstream passage of salmon are variable and may affect their rates of reproduction. A basic premise is that a portion of the different spawning groups that return to areas above the rapids are arriving early in the run to meet lower flow conditions that are generally more favorable to upstream passage. Results of earlier tagging studies conducted in 1957-1959 showed Lake Clark stocks having a slightly higher number of early-run fish in all three years (12). Some additional evidence for this is provided by studies in recent years when Newhalen River-Lake Clark stocks have been a major contributor in the Kvichak run. In these years there has been a tendency for the Newhalen River fish to be strongly represented in the early part of the run (3, 4 and 13).

6.2 Comparison of 1984 Escapement Studies to Other Years

Daily escapement information from the Newhalen RM 22 enumeration program (Table 3 and Appendix Table A3), the Newhalen RM 1 10-hour index program (Table 4 and Appendix Table A4), the Kvichak River Igiugig enumeration program (Table 3 and Appendix Tables A3 and A4), and from Kvichak run curves time referenced to the head of the Kvichak River, is compared for the time period 1979-1984 in Figure 10. The largest Kvichak run and escapement occurred in 1980, followed by 1979, 1984, 1983, 1981 and 1982, respectively. The largest Newhalen River 10-hour index occurred in 1979, followed by 1980, 1984, 1983 and 1982, respectively. However,

a larger escapement most certainly occurred at RM 22 in 1979 when no enumeration program was conducted at that location. The duration of salmon escapement past RM 22 is correlated with the size of the Kvichak escapement, e.g., the larger the Kvichak escapement the longer it takes the Newhalen River-Lake Clark component to pass the RM 22 counting station. In reference to the pattern of escapement, while the Kvichak River pattern of escapement is frequently repeated at the Newhalen RM 1 index station, this pattern is not normally repeated at RM 22. However, in most years of our observations we have noted that a small portion of fish moved swiftly through the system past RM 22 in a pattern similar to that observed first at Igiugig and then at RM 1. This indicates the possibility that there is segregation of different spawning components of the Newhalen River-Lake Clark system in the Kvichak run.

Explanation of the differences we have observed in the patterns of escapement at RM 22 can also be investigated through a comparison of the daily patterns of escapement levels to patterns of Newhalen River discharge (Figure 11). While the high river discharge rates in 1980 resulted in creating prolonged velocity blocks to salmon passage in the rapids areas of the Newhalen River (4, 5 and 10), the effects of river discharge on the patterns of RM 22 escapements in other years is not that apparent. However, there is the suggestion in three out of the other four years (e.g., 1981, 1982 and 1984) that peak periods of salmon passage at RM 22 corresponded to the greatest rate of increasing flows during the period when adult salmon were abundant in the system. Therefore, increased upstream passage rates of salmon that have entered the Newhalen River may result from a stimulus related to rapidly increasing

river discharge. Escapement enumeration studies conducted on two sockeye salmon river systems in British Columbia showed peak periods of upstream passage were associated with high water levels (14). Certainly while this possible explanation is highly speculative, it serves to emphasize the need for further study of the upstream passage of salmon through the Newhalen River.

Differences in the timing of the observed escapements past RM 22 can be examined further through the comparison of cumulative proportion escapement curves (Figure 12). When the dates when 50 percent of the cumulative total escapement was reached at RM 22 are compared, the differences that occur appear too great to be adequately explained by the observed differences in run size, run timing, and patterns of river discharge that were discussed above. This emphasizes the need to study both the timing of the Newhalen River-Lake Clark component in the Kvichak run and the passage of the different spawning groups up the Newhalen River.

6.3 Recent Salmon Production in the Newhalen River-Lake Clark System

The recent importance of Newhalen River-Lake Clark salmon production relative to the total production of the Kvichak River system and Bristol Bay is examined in Table 6. During the period 1979-1984 salmon runs to the Newhalen River-Lake Clark system have represented 15 to 80 percent (mean 43 percent) of the total Kvichak run, and 3 to 49 percent (mean 19 percent) of the total Bristol Bay run. Thus, the salmon runs to the Newhalen River-Lake Clark system represent a very important component of the Bristol Bay salmon resource.

6.4 Incidental Observations Concerning Newhalen River Juvenile Salmon Migrations

While there was no direct sampling of juvenile sockeye salmon migrating downstream past RM 22 during the 1984 adult salmon enumeration program, visual observations concurrent with other information from the index townet sampling conducted by FRI in Six-Mile Lake indicated that a very substantial downstream migration of sockeye fry occurred at dusk the evening of August 7. It was the largest summer migration of fry that we have observed at RM 22. A 1-minute duration townet haul by FRI in Six-Mile Lake the same evening caught an estimated 10-15 pounds of salmon fry. FRI townet sampling in Six-Mile Lake 5 days later, August 12, indicated much lower densities of fry than on August 7. However, very substantial numbers of fry were still present in Six-Mile Lake. The size of fry caught in Six-Mile Lake on August 7 ranged from 36-67 mm with a mean length of approximately 50 mm. These observations indicate a substantial production of fry from the 1983 Newhalen RM 22 escapement of 703,000.

The above information seems to corroborate the findings of recent Newhalen River studies (1982-1984) by D&M and FRI supported by APA which showed the migratory habits of juvenile sockeye salmon in the Newhalen River-Lake Clark system to be very complex (9, 15, and 16). The information collected indicates that juvenile sockeye salmon move from the Six-Mile Lake-Lake Clark system to Iliamna Lake through much of the open water period in the spring, summer and fall.

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Table 1. Summary of grouped data[1/] used to estimate the regression equation[2/] relating 20-hour to 24-hour counts of sockeye salmon at the Newhalen RM 22 enumeration station in 1984.

Range of the sum of daily 10-minute counts (1)	Number of observations	Mean of the sum of 10-minute counts 20-hours (04-24h) (2)	Mean of the sum of 10-minute counts 24-hours (00-24h) (3)	Proportion of daily total of hourly 10-minute counts (04-24h) (2)÷(3)	Expanded daily escapement range (1) x 6
0- 1,000	10	526.3	562.6	.9355	0- 6,000
1,000- 2,000	5	1,530.4	1,608.6	.9514	6,000- 12,000
2,000- 3,000	4	2,366.5	2,460.5	.9614	12,000- 18,000
3,000- 5,000	4	3,661.0	3,772.5	.9704	18,000- 25,000
5,000-25,000	4	14,629.0	15,170.3	.9643	25,000-150,000

1/See Appendix Table A1 for a summary of the basic data collected 1980-1984, and Appendix Table A2 for the input data used to create the above grouped data sets.

2/Regression equation:

$$Y = 8.4760 + 1.0361(X)$$

where: Y = Estimated total of 24 hourly 10-minute counts (00-24h) of sockeye salmon at Newhalen RM 22.

X = Total of 20 hourly 10-minute counts (04-24h) of sockeye salmon at Newhalen RM 22.

n = 5 data sets listed above.

Table 2. Comparison of daily escapement estimates from 20-hour and 24-hour counts of sockeye salmon, Newhalen RM 22 1984.

Date	Sum of 20-hours of counts (04-24h) (1)	Sum of 24-hours of counts (00-24h) (2)	Proportion 20-hour to 24-hour counts (1)÷(2)	RM 22 Estimates of cumulative escapement
June 29	[570]1/	[642]	.8889	642
30	[3,678]	[3,864]	.9519	4,506
July 1	12,996	13,518	.9614	18,024
2	23,634	24,534	.9633	42,558
3	23,652	24,558	.9631	67,116
4	28,800	29,892	.9635	97,008
5	55,782	57,846	.9643	154,854
6	50,244	52,104	.9643	206,958
7	64,338	66,708	.9645	273,666
8	63,906	66,258	.9645	339,924
9	60,456	62,688	.9644	402,612
10*	70,422	72,162	.9759	474,774
11*	59,376	60,294	.9848	535,068
12	58,386	60,540	.9644	595,608
13	70,686	73,284	.9645	668,892
14	46,854	48,594	.9642	717,486
15	49,572	51,408	.9643	768,894
16	56,910	59,010	.9644	827,904
17	48,474	50,274	.9642	878,178
18	26,604	27,612	.9635	905,790
19	26,844	27,864	.9634	933,654
20	39,306	40,776	.9639	974,430
21	29,856	30,984	.9636	1,005,414
22	29,052	30,150	.9636	1,035,564
23*	24,702	25,182	.9809	1,060,746
24	29,472	30,588	.9635	1,091,334
25	26,946	27,966	.9635	1,119,300
26	43,374	44,988	.9641	1,164,288
27	39,174	40,638	.9640	1,204,926
28	48,996	50,814	.9642	1,255,740
29	41,976	43,542	.9640	1,299,282
30	48,168	49,956	.9642	1,349,238
31	30,810	31,974	.9636	1,381,212
Aug. 1	48,540	50,340	.9642	1,431,552
2	79,122	82,026	.9646	1,513,578
3	63,192	65,520	.9645	1,579,098
4	61,164	63,420	.9644	1,642,518
5	112,746	116,862	.9648	1,759,380
6	79,284	82,194	.9646	1,841,574
7*	97,062	99,912	.9715	1,941,486
8*	124,206	131,718	.9430	2,073,204
9	102,858	106,620	.9647	2,179,824
10	132,546	137,376	.9648	2,317,200
11	96,720	100,260	.9647	2,417,460
12	72,180	74,832	.9646	2,492,292
13	98,526	102,132	.9647	2,594,424
14	106,284	110,166	.9648	2,704,590
15	104,892	108,726	.9647	2,813,316
16	100,800	104,484	.9647	2,917,800
17	78,978	81,876	.9646	2,999,676
18	23,262	24,150	.9632	3,023,826
19	28,740	29,826	.9636	3,053,652
20	[20,448]	[21,240]	.9627	3,074,892
21	[12,162]	[12,654]	.9611	3,087,546
22	(3,882)2/	(4,074)	.9529	3,091,620
Totals	2,981,610	3,091,620	.9644	3,091,620

1/Values in brackets [ ] for 29 and 30 June represent escapement estimates derived from catch information from resident subsistence fisheries; for 20 and 21 August escapement values represent linear estimates between 19 and 22 of August.

2/Values in parentheses ( ) represent escapement estimates expanded from 4 hours of counting.

*Represents days of 24-hour counting.

Table 3. Daily estimates of sockeye salmon escapement Kvichak River (Igiugig) and Newhalen River (RM 22), 1984.

Calendar	Julian	Kvichak River (Igiugig)[1/] Daily count (1)	Kvichak River (Igiugig)[1/] Cumulative count (2)	Kvichak River (Igiugig)[1/] Percent of total Daily (3)	Kvichak River (Igiugig)[1/] Percent of total Cumulative (4)	Newhalen River - RM 22 Daily count (5)	Newhalen River - RM 22 Cumulative count (6)	Newhalen River - RM 22 Percent of total Daily (7)	Newhalen River - RM 22 Percent of total Cumulative (8)	Percent of Igiugig (6÷2 x 100)
June 20	172	168	168	.00	.00					
21	173	42	210	.00	.00					
22	174	6	216	.00	.00					
23	175	258	474	.00	.00					
24	176	426	900	.00	.01					
25	177	16,578	17,478	.16	.17					
26	178	68,946	86,424	.66	.82					
27	179	34,206	120,630	.33	1.15					
28	180	12,504	133,134	.12	1.27					
29	181	671,250	804,384	6.40	7.67	642	642	.02	.02	.08
30	182	1,017,054	1,821,438	9.69	17.36	3,864	4,506	.12	.15	.25
July 1	183	778,200	2,599,638	7.42	24.78	13,518	18,024	.44	.58	.69
2	184	516,378	3,116,016	4.92	29.70	24,534	42,558	.79	1.38	1.37
3	185	514,080	3,630,096	4.90	34.60	24,558	67,116	.79	2.17	1.85
4	186	689,580	4,319,676	6.57	41.18	29,892	97,008	.97	3.14	2.25
5	187	793,596	5,113,272	7.56	48.74	57,846	154,854	1.87	5.01	3.03
6	188	854,580	5,967,852	8.15	56.89	52,104	206,958	1.69	6.69	3.47
7	189	819,480	6,787,332	7.81	64.70	66,708	273,666	2.16	8.85	4.03
8	190	794,136	7,581,468	7.57	72.27	66,258	339,924	2.14	11.00	4.48
9	191	855,420	8,436,888	8.15	80.42	62,688	402,612	2.03	13.02	4.77
10	192	555,960	8,992,848	5.30	85.72	72,162	474,774	2.33	15.36	5.28
11	193	229,194	9,222,042	2.18	87.91	60,294	535,068	1.95	17.31	5.80
12	194	136,014	9,358,056	1.30	89.20	60,540	595,608	1.96	19.27	6.36
13	195	390,366	9,748,422	3.72	92.92	73,284	668,892	2.37	21.64	6.86
14	196	283,446	10,031,868	2.70	95.63	48,594	717,486	1.57	23.21	7.15
15	197	79,284	10,111,152	.76	96.38	51,408	768,894	1.66	24.87	7.60
16	198	60,756	10,171,908	.58	96.96	59,010	827,904	1.91	26.78	8.14
17	199	98,478	10,270,386	.94	97.90	50,274	878,178	1.63	28.41	8.55
18	200	89,448	10,359,834	.85	98.75	27,612	905,790	.89	29.30	8.74
19	201	70,332	10,430,166	.67	99.42	27,864	933,654	.90	30.20	8.95
20	202	24,918	10,455,084	.24	99.66	40,776	974,430	1.32	31.52	9.32
21	203	11,880	10,466,964	.11	99.77	30,984	1,005,414	1.00	32.52	9.61
22	204	8,508	10,475,472	.08	99.86	30,150	1,035,564	.98	33.50	9.89
23	205	8,712	10,484,184	.08	99.94	25,182	1,060,746	.81	34.31	10.12
24	206	5,202	10,489,386	.05	99.99	30,588	1,091,334	.99	35.30	10.40
25	207	1,284	10,490,670	.01	100.00	27,966	1,119,300	.90	36.20	10.67
26	208					44,988	1,164,288	1.46	37.66	11.10
27	209					40,638	1,204,926	1.31	38.97	11.49
28	210					50,814	1,255,740	1.64	40.62	11.97
29	211					43,542	1,299,282	1.41	42.03	12.39
30	212					49,956	1,349,238	1.62	43.64	12.86
31	213					31,974	1,381,212	1.03	44.68	13.17
Aug. 1	214					50,340	1,431,552	1.63	46.30	13.65
2	215					82,026	1,513,578	2.65	48.96	14.43
3	216					65,520	1,579,098	2.12	51.08	15.05
4	217					63,420	1,642,518	2.05	53.13	15.66
5	218					116,862	1,759,380	3.78	56.91	16.77
6	219					82,194	1,841,574	2.66	59.57	17.55
7	220					99,912	1,941,486	3.23	62.80	18.51
8	221					131,718	2,073,204	4.26	67.06	19.76
9	222					106,620	2,179,824	3.45	70.51	20.78
10	223					137,376	2,317,200	4.44	74.95	22.09
11	224					100,260	2,417,460	3.24	78.19	23.04
12	225					74,832	2,492,292	2.42	80.61	23.76
13	226					102,132	2,594,424	3.30	83.92	24.73
14	227					110,166	2,702,590	3.56	87.48	25.78
15	228					108,726	2,813,316	3.52	91.00	26.82
16	229					104,484	2,917,800	3.38	94.38	27.81
17	230					81,876	2,999,676	2.65	97.03	28.59
18	231					24,150	3,023,826	.78	97.81	28.82
19	232					29,826	3,053,652	.96	98.77	29.11
20	233					21,240	3,074,892	.69	99.46	29.31
21	234					12,654	3,087,546	.41	99.87	29.43
22	235					4,074	3,091,620	.13	100.00	29.47
TOTALS		10,490,670	10,490,670	100.00	100.00	3,091,620	3,091,620	100.00	100.00	29.47

[1/] Data source: Kvichak River final daily escapement counts provided by Dick Russell/Don Bill, ADF&G Commercial Fish Division, King Salmon office, 3 August 1984.

Table 4. Daily estimates of sockeye salmon escapement Kvichak River (Igiugig) and daily 10-hour index of escapement Newhalen River (RM 1), 1984.

Date		Kvichak River (Igiugig)[1]		Newhalen River - RM 1 10h Index[2]		
		Daily	Cumulative	Daily 10h	Cumulative 10h	% of Igiugig
Calendar	Julian	count (1)	count (2)	index (3)	index (4)	(4÷2x100)
June 20	172	168	168			
21	173	42	210			
22	174	6	258			
23	175	258	474			
24	176	426	900			
25	177	16,578	17,478			
26	178	68,946	86,424	[528][3]	528	.61
27	179	34,206	120,630	[1,716]	2,244	1.86
28	180	12,504	133,134	4,890	7,134	5.36
29	181	671,250	804,384	1,584	8,718	1.08
30	182	1,017,054	1,821,438	6,798	15,516	.85
July 1	183	778,200	2,599,638	38,082	53,598	2.06
2	184	516,378	3,116,016	27,312	80,910	2.60
3	185	514,080	3,630,096	51,324	132,234	3.64
4	186	689,580	4,319,676	57,876	190,110	4.40
5	187	793,596	5,113,272	56,670	246,780	4.83
6	188	854,580	5,967,852	41,706	288,486	4.83
7	189	819,480	6,787,332	55,650	344,136	5.07
8	190	794,136	7,581,468	51,516	395,652	5.22
9	191	855,420	8,436,888	69,264	464,916	5.51
10	192	555,960	8,992,848	50,514	515,430	5.73
11	193	229,194	9,222,042	40,680	556,110	6.03
12	194	136,014	9,358,056	45,522	601,632	6.43
13	195	390,366	9,748,422	36,066	637,698	6.54
14	196	283,446	10,031,868			
15	197	79,284	10,111,152			
16	198	60,756	10,171,908			
17	199	98,478	10,270,386			
18	200	89,448	10,359,834			
19	201	70,332	10,430,166			
20	202	24,918	10,455,084			
July 21	203	11,880	10,466,964			
22	204	8,508	10,475,472			
23	205	8,712	10,484,184			
24	206	5,202	10,489,386			
25	207	1,284	10,490,670			
26	208					
27	209					
28	210					
29	211					
30	212					
31	213					
Aug 1	214					
2	215					
Totals			10,490,670		637,698	6.54

[1]Data source: Kvichak River final daily escapement counts provided by Dick Russell/Don Bill, ADF&G Commerical Fish. Division, King Salmon Office, 3 August 1984.

[2]Systematic daily 10-hour index program began 28 June. Represents the sum of hourly 10-minute counts from left bank (east bank) 08-17h multiplied by six.

[3]Values in brackets [ ] represent daily 10-hour index counts for 26 and 27 June estimated from relationship of Newhalen Village subsistence catches to RM 1 10h index at low rates of fish passage.

Table 5. Climatological and hydrological observations relevant to Newhalen River adult enumeration program, 1984.

Date		Sky 0800	Sky 2000	Wind 0800 Mph-Dir	Wind 2000 Mph-Dir	Temperature °C Air Min 2000h	Temperature °C Air Max 2000h	Temperature °C Water 2000h	Precip. (inches) 2000h	Water stage elevation (ft) RM 22 0800	RM 22 2000	RM 16 Gauge	RM 16 Well	RM 16 Estimated[3]	Estimated discharge RM 16 (cfs)	Turbidity
June	8											3.12		3.12*	8,310	1.0
	17											4.02	4.08	4.02*	11,670	1.0
	30											5.44	5.46	5.44*	17,650	1.0
July	1	3	6	0-9	2-2	[10.2]	[9.6][1]	10.3	.030	5.52	5.54			5.48	17,830	1.0
	2	4	3	0-9	0-9	[4.7]	[13.8]	9.6	.040	5.59	5.60	5.55	5.56	5.55*	18,145	1.0
	3	3	2	0-9	5-3	[8.6]	[19.8]	12.2	.000	5.60	5.62			5.54	18,100	1.0
	4	3	3	2-4	1-3	[9.4]	[11.3]	9.7	.000	5.56	5.56			5.50	17,920	1.0
	5	3	3	3-2	1-6	[10.5]	[18.5]	10.3	.000	5.58	5.62			5.54	18,100	1.0
	6	3	3	6-6	0-9	[9.5]	[13.8]	11.0	.000	5.60	5.65			5.56	18,190	1.0
	7	1	3	0-9	4-5	[9.6]	[17.0]	11.5	.000	5.70	5.74			5.63	18,505	1.0
	8	3	3	4-6	6-8	[10.4]	[16.8]	12.0	.000	5.80	5.82			5.71	18,865	1.0
	9	3	5	1-8	3-8	[13.3]	[11.0]	11.6	.030	5.86	5.88			5.76	19,090	1.0
	10	3	3	1-3	3-3	[7.0]	[16.5]	9.0	.070	5.88	5.91			5.78	19,180	1.0
	11	3	2	0-9	3-2	[9.4]	[13.1]	10.1	.220	5.93	5.94			5.81	19,316	1.0
	12	3	3	3-2	4-2	[11.0]	[11.5]	11.1	.015	5.92	5.89			5.79	19,225	1.0
	13	2	5	1-9	2-9	[7.5]	[10.5]	8.5	.510	5.89	5.89			5.77	19,135	1.0
	14	2	5	0-9	1-3	[5.3]	[11.1]	9.8	.040	5.89	5.84			5.76	19,090	1.0
	15	3	3	1-9	1-6	[8.0]	[18.4]	11.1	.030	5.80	5.80			5.70	18,820	1.0
	16	3	3	0-9	5-3	[4.5]	[15.0]	12.5	T	5.75	5.77			5.67	18,685	1.0
	17	3	3	0-9	5-2	[9.0]	[12.5]	10.4	.000	5.63	5.63			5.56	18,190	1.0
	18	3	3	4-3	1-2	[8.4]	[9.0]	8.2	.020	5.68	5.68			5.60	18,370	1.0
	19	3	3	1-3	2-3	[6.6]	[9.3]	6.5	.050	5.68	5.70			5.61	18,415	1.0
	20	3	5	1-9	0-9	[8.8]	[11.6]	7.1	.200	5.69	5.69			5.61	18,415	1.0
	21	3	2	1-9	4-3	[13.0]	[14.5]	8.2	.016	5.68	5.63			5.58	18,280	1.0
	22	3	3	1-3	2-2	[11.8]	[11.0]	8.3	.000	5.60	5.59	5.52		5.52*	18,010	1.0
	23	3	3	0-9	3-4	15.0	20.5	8.5	.000	5.58	5.55			5.51	17,965	1.0
	24	3	3	0-9	3-1	8.5	20.0	9.5	.000	5.55	5.56			5.50	17,920	1.0
	25	3	3	0-9	2-4	9.0	16.5	9.5	T	5.55	5.53			5.49	17,875	1.0
	26	3	3	0-9	4-3	10.0	20.0	10.5	T	5.51	5.47			5.45	17,695	1.0
	27	3	2	0-9	4-3	11.0	23.0	10.5	.000	5.47	5.45			5.42	17,560	1.0
	28	3	3	0-9	5-3	10.5	19.0	10.5	.000	5.45	5.45			5.41	17,515	1.0
	29	3	5	1-3	2-2	9.0	14.0	10.0	.067	5.45	5.47			5.42	17,560	1.0
	30	3	3	0-9	3-3	9.0	16.5	10.5	.020	5.47	5.47			5.43	17,605	1.0
	31	3	6	4-3	1-3	10.5	14.0	9.5	.200	5.44	5.45			5.41	17,515	1.5
August	1	5	1	0-9	5-3	10.5	20.0	10.5	.200	5.41	5.41			5.38	17,382	1.5
	2	1	3	0-9	5-4	8.5	19.5	11.5	.000	5.40	5.31			5.34	17,206	1.6
	3	3	3	0-9	2-3	12.6	21.2	11.8	.000	5.35	5.35	5.28		5.28*	16,942	1.5
	4	3	2	0-9	1-9	14.0	25.7	13.0	.000	5.37	5.38			5.36	17,294	1.5
	5	4	3	0-9	3-3	9.2	20.6	12.0	.000	5.39	5.44			5.39	17,426	1.6
	6	3	1	0-9	1-9	11.7	23.2	12.5	.000	5.52	5.56	5.47	5.51	5.47*	17,740	1.3
	7	1	3	0-9	2-2	6.0	24.5	13.5	.000	5.59	5.61			5.54	18,100	1.4
	8	1	3	0-9	3-6	6.8	25.0	13.0	.000	5.65	5.68			5.59	18,325	1.3
	9	1	3	6-2	6-3	7.0	24.5	13.5	.000	5.68	5.68			5.60	18,370	1.3
	10	5	6	6-2	6-2	11.0	15.0	12.8	.450	5.70	5.71			5.63	18,505	1.3
	11	3	2	3-7	2-6	10.0	24.0	13.0	.250	5.72	5.74			5.64	18,550	1.7
	12	1	1	0-9	1-9	9.0	24.5	13.6	.000	5.72	5.70			5.63	18,505	1.7
	13	1	1	0-9	1-9	5.0	26.0	14.3	.000	5.67	5.65			5.58	18,280	1.6
	14	1	1	0-9	2-6	9.0	25.0	14.5	.000	5.62	5.60			5.54	18,100	1.6
	15	1	1	4-7	1-7	9.0	25.5	15.0	.000	5.58	5.55			5.51	17,965	1.6
	16	2	3	0-9	4-4	5.5	23.5	14.0	.000	5.52	5.46			5.45	17,695	1.7
	17	5	5	4-4	5-4	13.0	15.0	13.5	.035	5.45	5.46			5.42	17,560	1.8
	18	6	3	0-9	1-7	10.0	16.0	13.0	.690	—	5.56	5.45	5.54	5.45*	17,695	1.8
	19	3	1	5-7	2-8	6.5	16.5	12.5	.020	5.51	5.55			5.48	17,830	1.4
	22	3	3	4-5	(3.0)		(15.0)[2]	12.2	(.580)[2]	5.59	—			5.51*	17,965	2.5
	31	1	1	3-8	3-8	(-1.0)	(16.5)	10.2	(1.330)	—	5.91	5.51	5.53	5.79	19,225	1.5
Sept.	1	1	1	1-5	0-0	3.5	18.0	10.5	.000	5.86	5.79			5.72	18,910	1.5
	2	1	1	1-5	3-5	-2.0	20.5	11.8	.000	5.72	5.68	5.50	5.57	5.50*	17,920	1.5
	16	1	1	—	2-5	(-1.0	(21.0)	—	(.420)	—	4.06	4.18	4.24	4.18*	12,310	1.4

Sky code:

1 Cloud cover less than 1/10 of sky
2 " " " " 1/2 " "
3 " " more " 1/2 " "
4 Fog or thick haze
5 Intermittant rain
6 Continuous rain

Precipitation: T = trace

Wind direction code:

1	NE	6	W
2	E	7	NW
3	SE	8	N
4	S	9	Unknown
5	SW		

Wind velocity code: Knots

0	Calm	0
1	Light airs	1-3
2	Light breeze	4-6
3	Gentle breeze	7-10
4	Moderate breeze	11-16

Turbidity code:

		Depth viz. feet
1.0	Clear	> 6
1.5	Lightly colored	5
2.0	Moderately "	4
2.5	Heavily "	3

[1] Values in brackets [ ] represent air temperatures taken at 08 and 2000h respectively, when max/min thermometer was malfunctioning.
[2] Numbers in parentheses represent values over an extended period of observation, e.g., over periods 8/20-8/22, 8/22-8/31, and 9/02-9/16.
[3] Estimated from regression equation: Y = .9759 + .8143(X), where X = RM 22 water stage elevations in feet (average of 08 and 20h readings).
[4] Discharge calculated from U.S. Geological Survey rating curve for RM 16.
*Actual readings from RM 16 gauge.

Table 6. Comparison of estimated total sockeye salmon runs (in thousands) to the Newhalen River-Lake Clark system, the entire Kvichak River system, and total Bristol Bay, 1979-1984.

		Kvichak River system						Newhalen River - Lake Clark system					
Year of run	Bristol Bay (1) Total inshore return	(2) Counted escapement (E)	(3) Catch (C) (4-2)	(4) Total run (R) (2+3)	(5) Catch % total run (3÷4x100)	(6) Ratio R/E (4÷2)	(7) Run % total Bristol Bay (4÷1x100)	(8) Counted escapement Newhalen RM 22	(9) Estimated[1] total escapement to system	(10) Total run (6x9)	(11) Contribution to Kvichak (C) (10-9)	(12) Run % total Kvichak run (10÷4x100)	(13) Run % total Bristol Bay run (10÷1x100)
1979	40,487	11,218	13,703	24,921	54.99	2.22	61.55	--	9,000	19,980	10,980	80.17	49.35
1980	62,276	22,505	12,729	35,234	36.13	1.57	56.58	1,503	7,500	11,775	4,275	33.42	18.91
1981	34,426	1,754	5,206	6,960	74.80	3.97	20.22	232	264	1,048	784	15.06	3.04
1982	22,222	1,135	1,500	2,635	56.93	2.32	11.86	147	280	650	370	24.67	2.93
1983	45,416	3,570	16,422	19,992	82.14	5.60	44.02	703	1,109	6,210	5,101	31.06	13.67
1984	40,719	10,491	12,281	22,772	53.93	2.17	55.92	3,092	3,759	8,157	4,398	35.82	20.03
Total	245,546	50,673	61,841	112,514				5,677	21,912	47,820	25,908		
Range	22,222 to 62,276	1,135 to 22,505	1,500 to 16,422	2,635 to 35,234	36.13 to 82.14	1.57 to 5.60	11.86 to 61.55	147 to 3,092	264 to 9,000	650 to 19,980	370 to 10,980	15.06 to 80.17	2.93 to 49.35
Percent (1) Mean					59.82	2.98	41.69					36.70	17.99
(2) From cumulative totals					54.96	2.22	45.82					42.50	19.47

[1] Total escapement estimates for Newhalen River-Lake Clark system for 1979 and 1980 based on 24-hour counting programs at RM 1. Data sources (4 & 5). Values for 1981-1984 obtained by adding peak spawning ground index counts of sockeye salmon for areas below Newhalen RM 22 multiplied by a factor of 2 to RM 22 counted escapements.

Data Sources: Bristol Bay and Kvichak run data compiled from Bristol Bay Area Management Reports and data provided by Henry Yuen and Steve Fried.

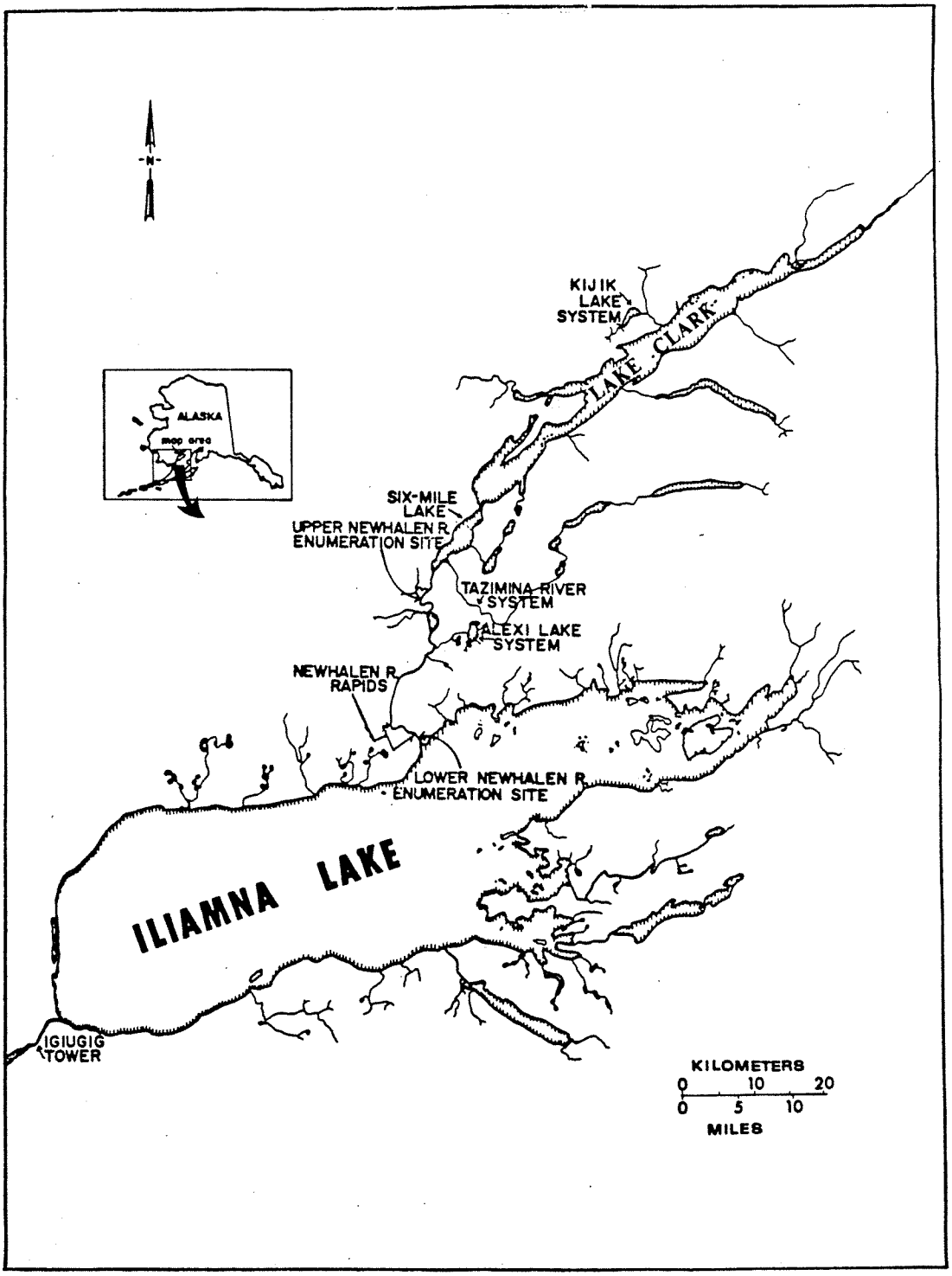


Fig. 1. Kvichak River system showing the location of the ADF&G Igiugig enumeration station, the FRI Newhalen River counting stations at RM 1 and RM 22, and the major sockeye salmon spawning units of the Newhalen River-Lake Clark system.

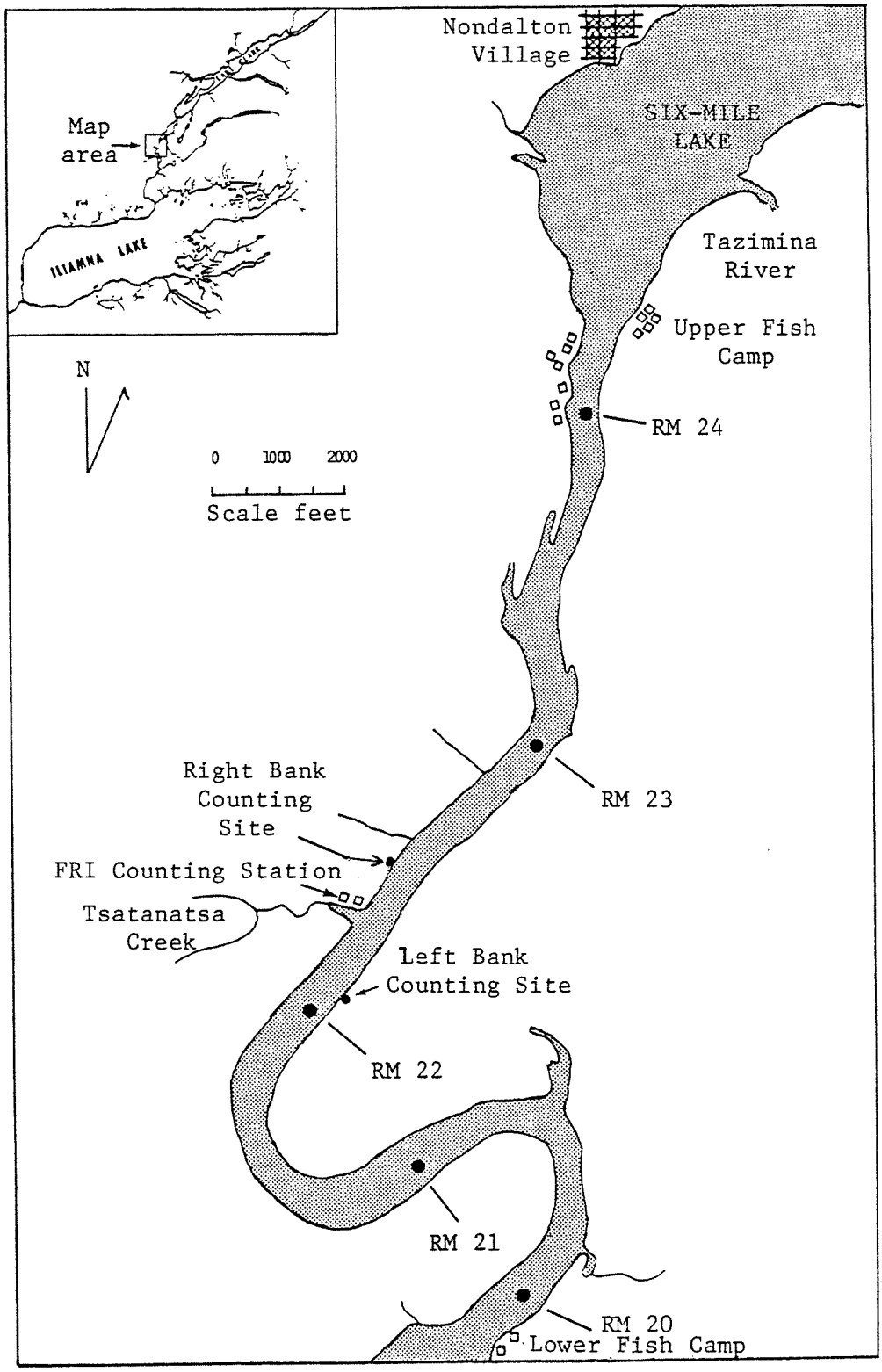


Figure 2. Location of the RM 22 adult salmon enumeration station and counting sites used since 1981.

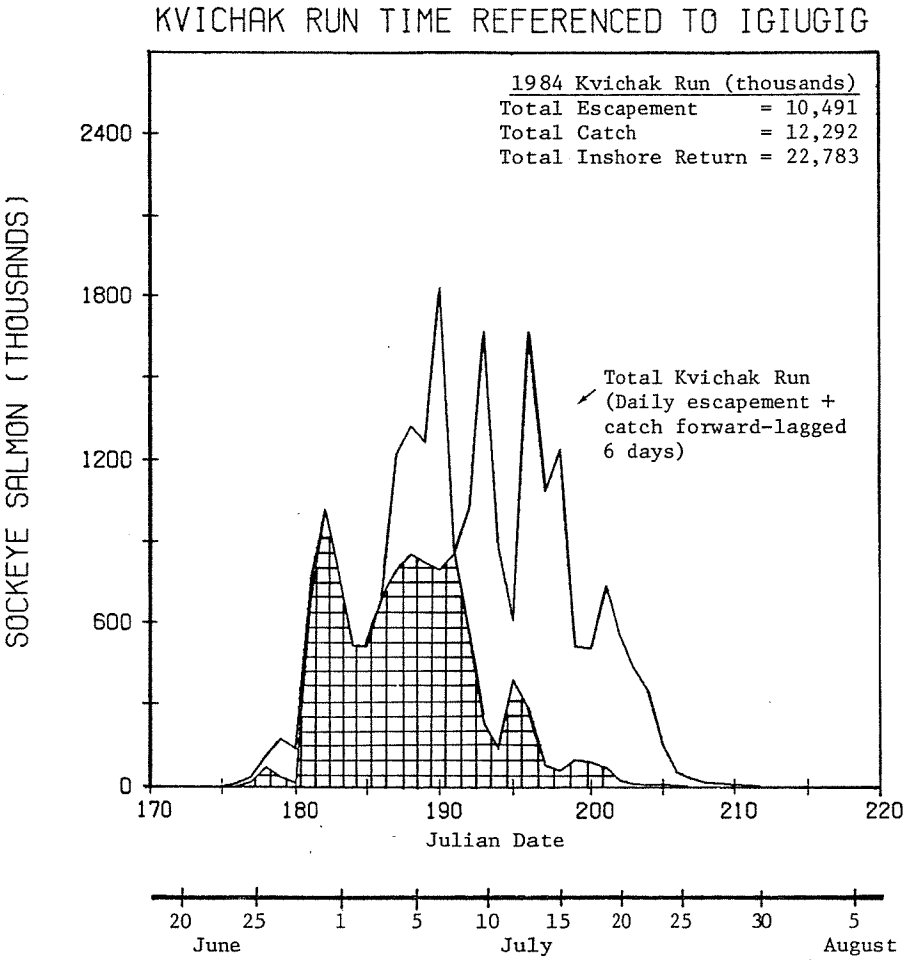


Figure 3. Kvichak River system 1984 sockeye salmon daily run curve time referenced to the head of the Kvichak River. Shaded areas represent daily escapements; unshaded areas represent catch.
Data source: 1984 ADF&G Bristol Bay Summary (September 1984) and personal communication, Steve Fried 10/23/84.
Procedure used in calculating daily Kvichak runs:
Daily Naknek-Kvichak District catches multiplied by .86334 (portion Kvichak catch represented of total Naknek-Kvichak District catch). This catch was forward-lagged 6 days and added to the daily Igiugig escapements. Toward the beginning and the end of the run the weekly catches were apportioned over a period of days.

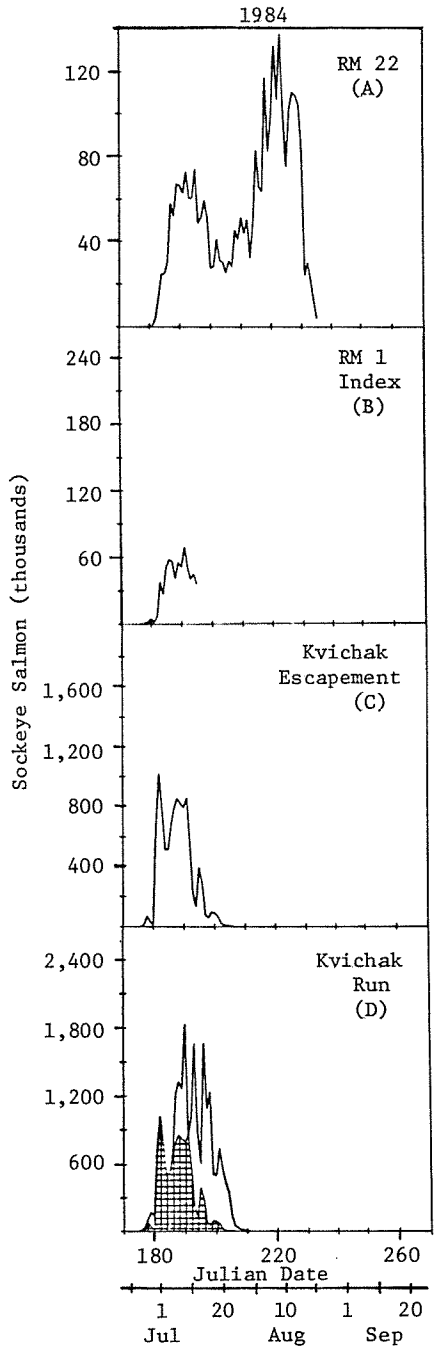


Figure 4. Comparison of 1984 daily escapement patterns of sockeye salmon at Newhalen RM 22 (A), Newhalen RM 1 10-hour index site (B), Kvichak River ADF&G Igiugig counting station (C), and in the Kvichak run time referenced to the head of the Kvichak River (D). Shaded areas of Kvichak run curve represent escapement; unshaded areas represent catch.

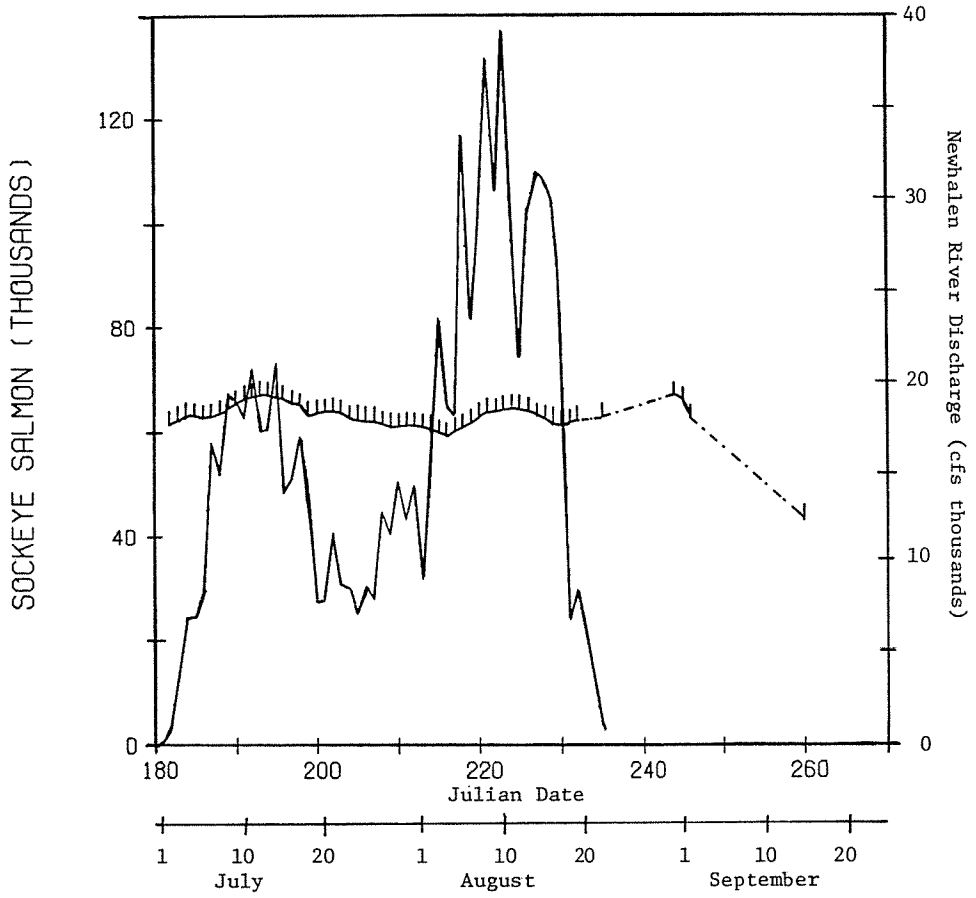


Figure 5. Pattern of daily escapement at Newhalen RM 22 (solid) and estimated Newhalen River discharge (symbol), 1984. Note: Broken line between symbols represents a linear interpolation of missing values.

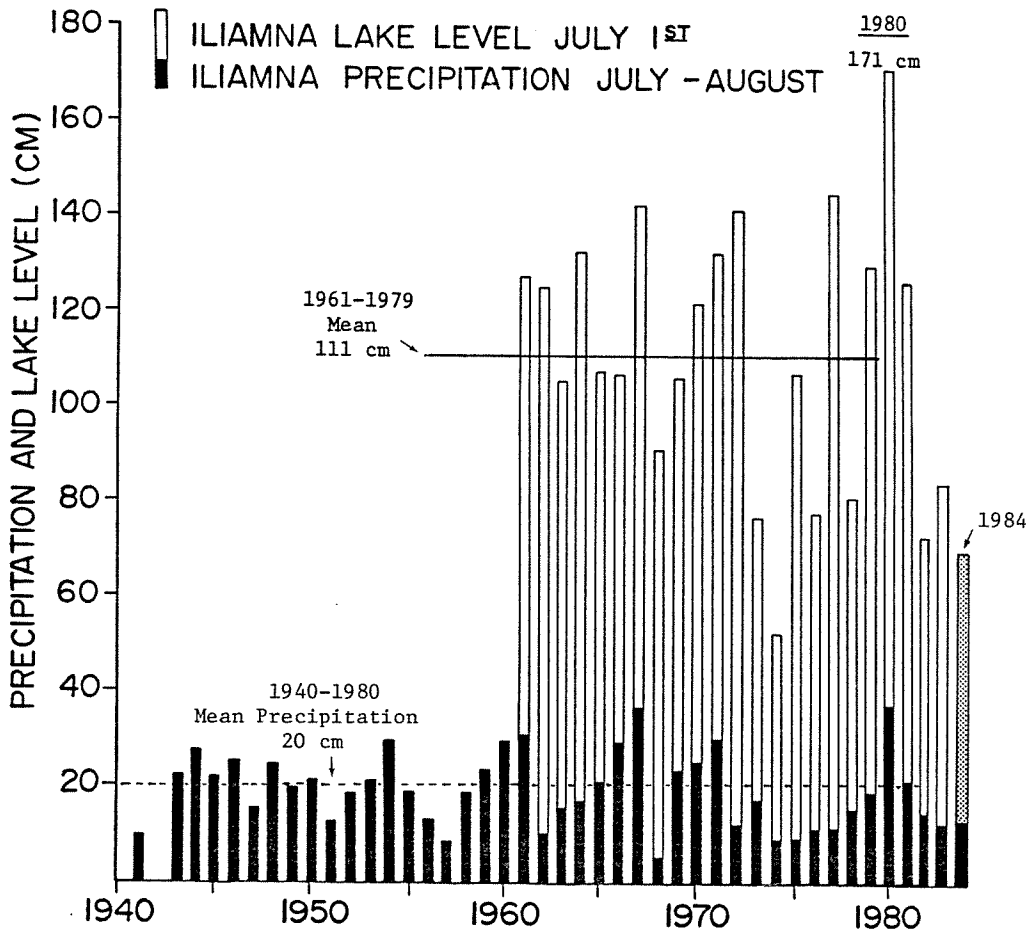


Figure 6. Comparison of 1984 July-August precipitation and Iliamna Lake level July 1, to fluctuations in precipitation 1940-1983, and Iliamna Lake level 1961-1983.

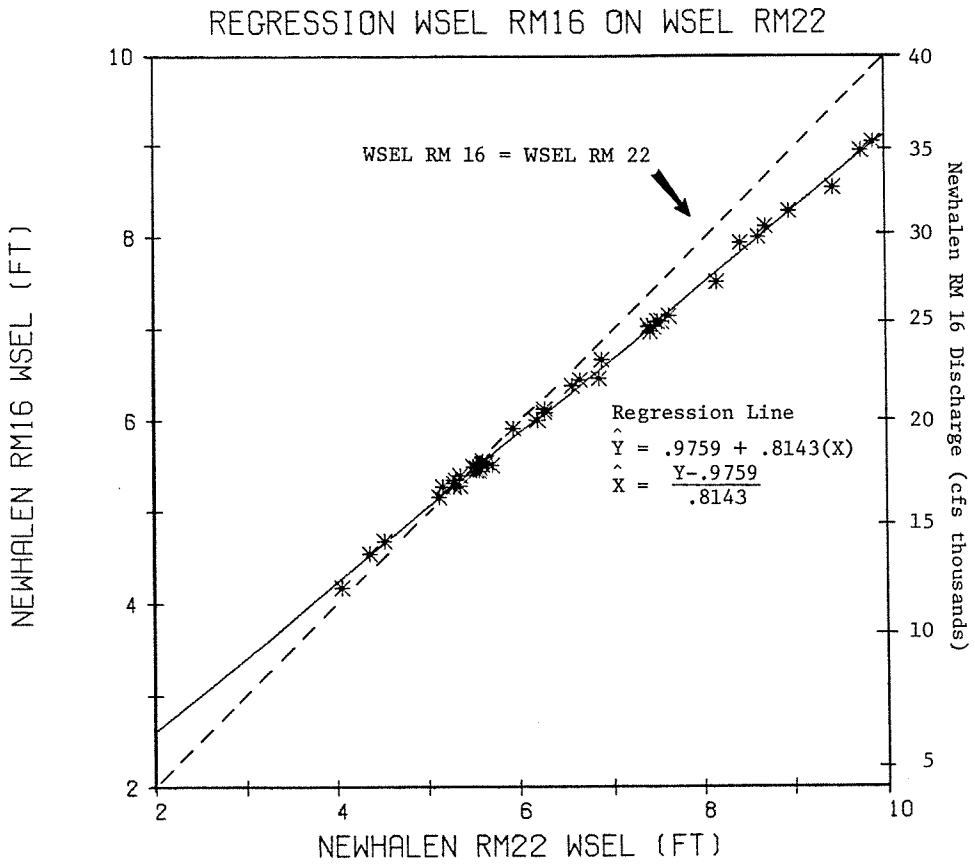


Figure 7. Relationship of Newhalen RM 16 water stage elevation to RM 22 water stage elevation (WSEL), from observations 1980-1984.

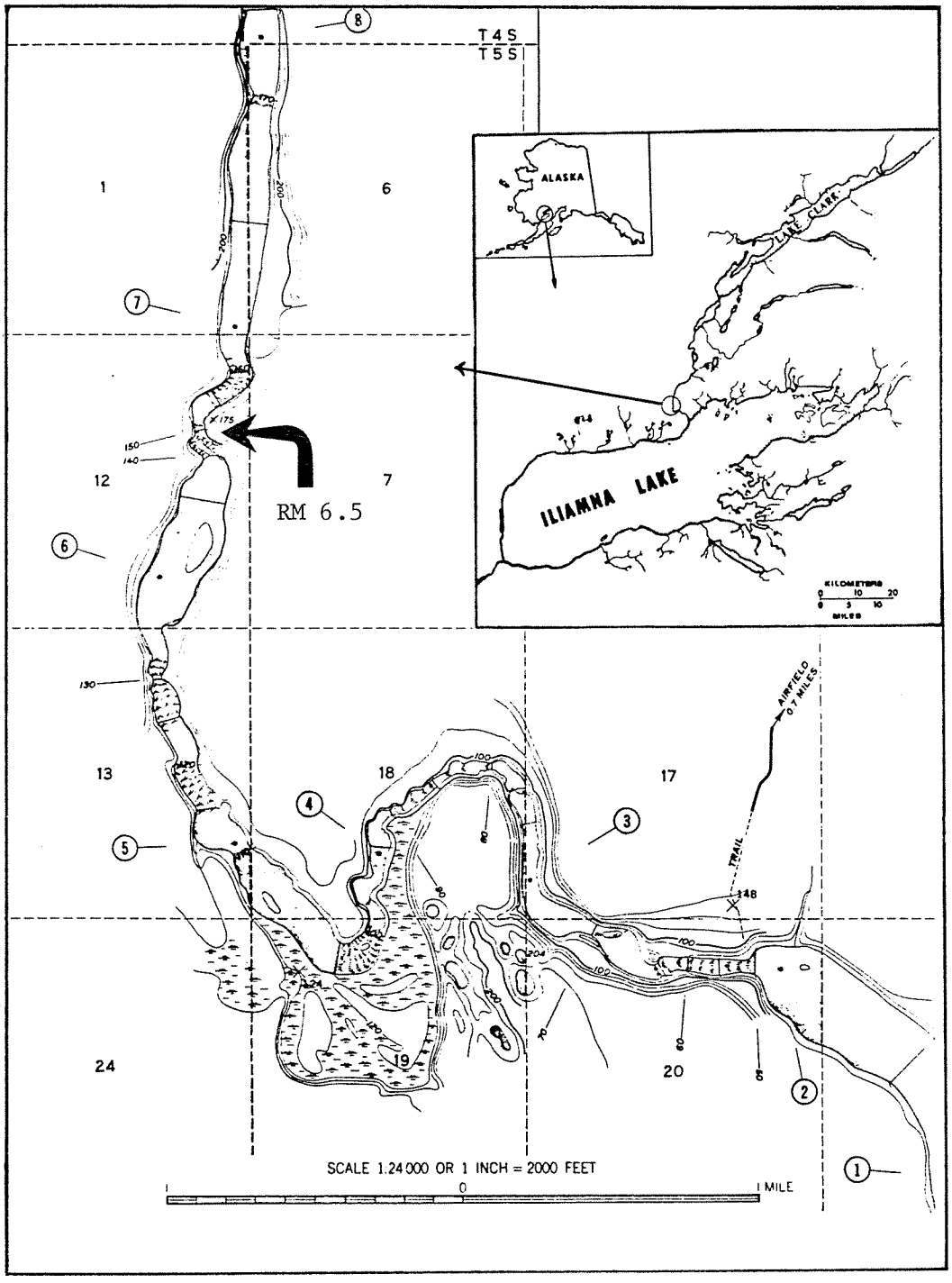


Figure 8. Location of RM 6.5 in the rapids area of the Newhalen River.

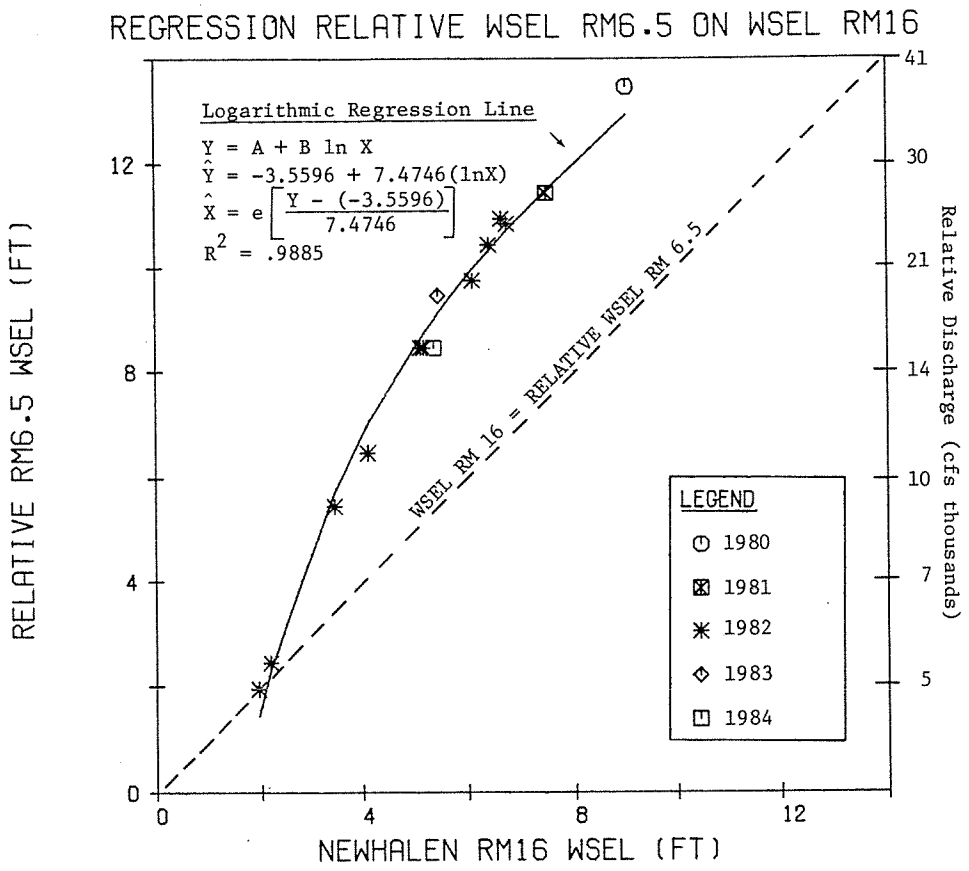


Figure 9. Relationship of relative river stage elevation and discharge Newhalen RM 6.5 to RM 16 water stage elevation (WSEL) from observations, 1980-1984.
Note: WSEL values for RM 6.5 = staff gauge readings plus 1.95 ft.

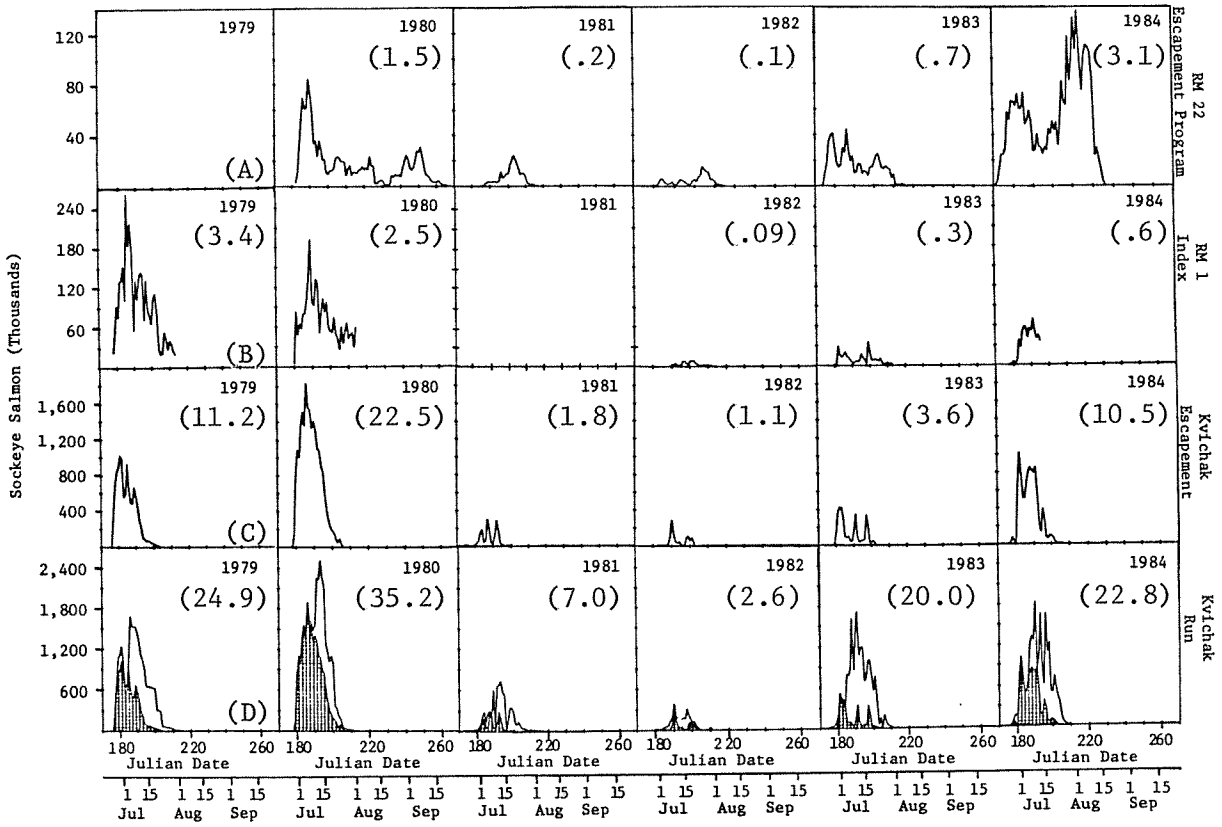


Figure 10. Comparison of daily escapement patterns of sockeye salmon at Newhalen RM 22 (A), Newhalen RM 1 10-hour index site (B), Kvichak River Igiugig counting station (C), and in the Kvichak run time referenced to the head of the Kvichak River (D), 1979-1984. Shaded areas of Kvichak run curves represent escapement; unshaded areas represent catch. Numbers in parentheses ( ) represent total escapement, total escapement index, or total run size in millions.
Note: No RM 22 escapement enumeration program in 1979 and no RM 1 10-hour index program in 1981.

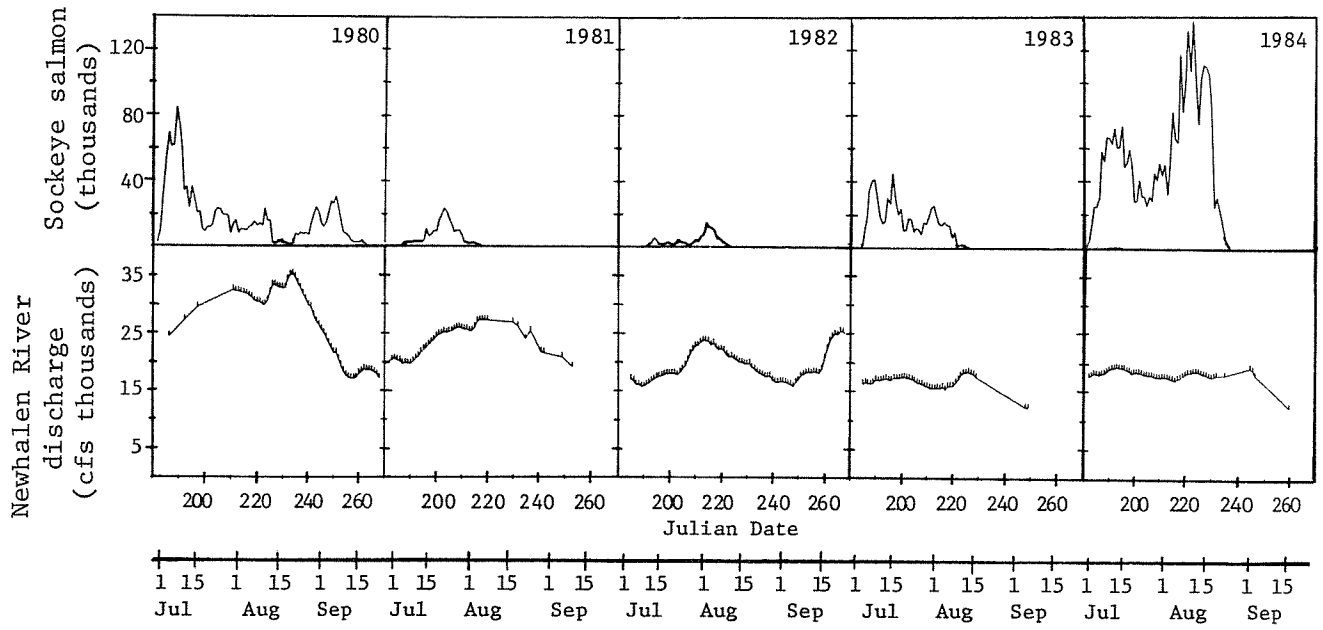


Figure 11. Comparison of daily patterns of escapement at RM 22 (upper graph) and estimated Newhalen River discharge (lower graph), 1980-1984.

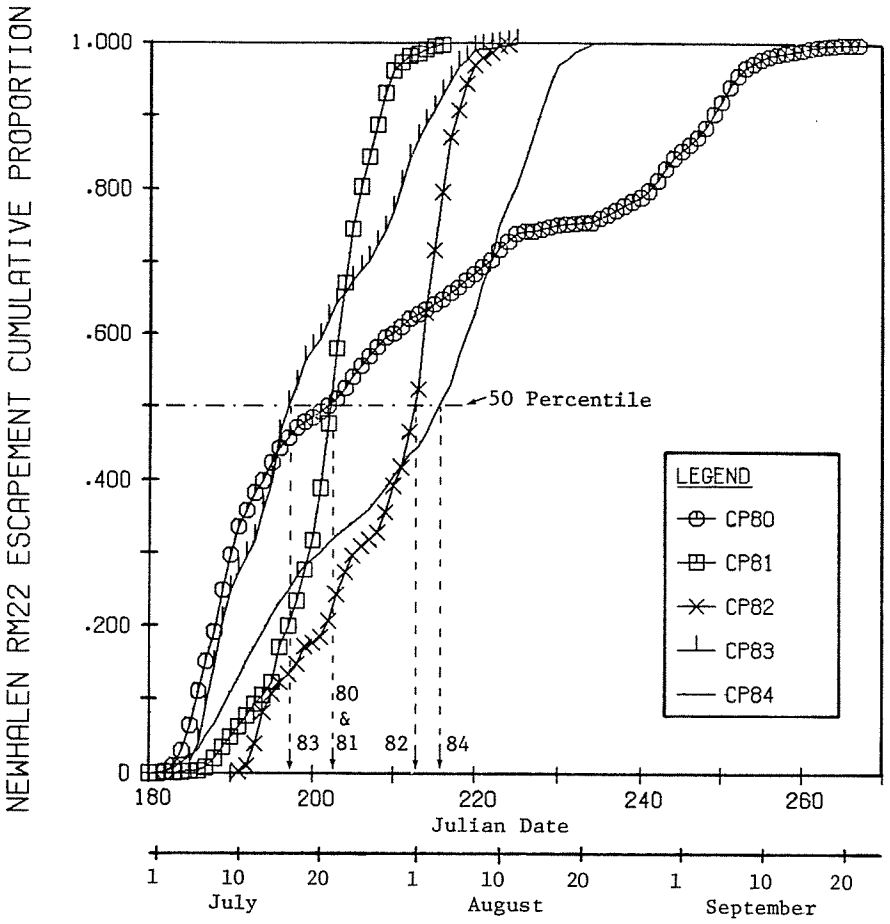


Figure 12. Comparison of cumulative proportion escapement curves of sockeye salmon at Newhalen RM 22 counting station, 1980-1984.

Appendix Table A1. Summary of data from all days of 24-hour counting at Newhalen RM 22 enumeration station, 1980-1984.

Date		Sum of hourly 10-minute counts 00-04h (1)	04-24h (2)	00-24h (1)+(2) (3)	Night count proportion (1) ÷ (3)	Daily escapement estimate (expanded total) (3) x 6
1980						
July	6*	275	9,971	10,246	.0268	61,476
	23*	41	3,864	3,905	.0105	23,430
1981						
July	20	157	3,214	3,371	.0466	20,226
	21	118	3,862	3,980	.0296	23,880
	22	91	3,451	3,542	.0257	21,252
	23	155	2,733	2,888	.0537	17,328
	24	117	2,093	2,210	.0529	13,260
	25*	26	1,507	1,533	.0170	9,198
	28	63	1,138	1,201	.0525	7,206
1982						
July	16	28	315	343	.0816	2,058
	18	14	130	144	.0972	864
	20	30	513	543	.0552	3,258
	21	21	866	887	.0237	5,322
	22	38	709	747	.0509	4,482
	24	21	295	316	.0665	1,896
	25	27	203	230	.1174	1,380
	30	52	1,140	1,192	.0436	7,152
August	1	74	2,509	2,583	.0286	15,498
	2	30	2,131	2,161	.0139	12,966
	3	106	1,834	1,940	.0546	11,640
	4	34	1,782	1,816	.0187	10,896
	5	32	876	908	.0352	5,448
	6	111	788	899	.1235	5,394
	7	41	568	609	.0673	3,654
1983						
July	23	136	1,758	1,894	.0718	11,364
1984						
July	10	290	11,737	12,027	.0241	72,162
	11	153	9,896	10,049	.0152	60,294
	23	80	4,117	4,197	.0191	25,182
August	7	475	16,177	16,652	.0285	99,912
	8	1,247	20,706	21,953	.0568	131,718
Range		14 to 1,247	130 to 20,706	144 to 21,953	.0105 to .1235	864 to 131,718
Totals**		3,741	95,541	99,282	.0377	595,692

*Night counts were made but not representative of fish passage due to poor counting conditions. These data are not included in the data set used to estimate the regression equation relating 20-hour to 24-hour counts used to expand the 1984 data.

**Totals do not include data from 1980 night counts or data from 25 July 1981.

Appendix Table A2. Summary of data used to generate the grouped data set which is used to estimate the regression equation relating 20-hour to 24-hour counts, Newhalen RM 22 1984.

Range of the sum of daily 10-minute counts	Date			Sum of hourly 10-minute counts			Proportion of daily total of hourly 10-minute counts		Daily escapement estimates (expanded total)
				00-04h	04-24h	00-24h	Night 00-04h	20h count 04-24h	
	Year	Month	Day	(1)	(2)	(3)	(1)÷(3)	(2)÷(3)	(3) x 6
0 - 1,000	1982	July	16	28	315	343	.0816	.9184	2,058
			18	14	130	144	.0972	.9028	864
			20	30	513	543	.0552	.0448	3,258
			21	21	866	887	.0237	.9763	5,322
			22	38	709	747	.0509	.9491	4,482
			24	21	295	316	.0665	.9335	1,896
			25	27	203	230	.1174	.8826	1,380
		August	5	32	876	908	.0352	.9648	5,448
			6	111	788	899	.1235	.8765	5,394
			7	41	568	609	.0673	.9327	3,654
Totals		n = 10		363	5,263	5,626	.0645	.9355	33,756
Mean				36.3	526.3	562.6	.0645	.9355	3,376
1,000 - 2,000	1981	July	28	63	1,138	1,201	.0525	.9475	7,206
	1982	July	30	52	1,140	1,192	.0436	.9564	7,152
		August	3	106	1,834	1,940	.0546	.9454	11,640
			4	34	1,782	1,816	.0187	.9813	10,896
	1983	July	23	136	1,758	1,894	.0718	.9282	11,364
Totals		n = 5		391	7,652	8,043	.0486	.9514	48,258
Mean				78.2	1,530.4	1,608.6	.0486	.9514	96,516
2,000 - 3,000	1981	July	23	155	2,733	2,888	.0537	.9463	17,328
			24	117	2,093	2,210	.0529	.9471	13,260
	1982	August	1	74	2,509	2,583	.0286	.9714	15,498
			2	30	2,131	2,161	.0139	.9861	12,966
Totals		n = 4		376	9,466	9,842	.0382	.9618	59,052
Mean				94	2,366.5	2,460.5	.0382	.9618	14,763
3,000 - 5,000	1981	July	20	157	3,214	3,371	.0466	.9534	20,226
			21	118	3,862	3,980	.0296	.9704	23,880
			22	91	3,451	3,542	.0257	.9743	21,252
	1984	July	23	80	4,117	4,197	.0191	.9809	25,182
Totals		n = 4		446	14,644	15,090	.0296	.9704	90,540
Mean				111.5	3,661	3,772.5	.0296	.9704	22,635
5,000 - 25,000	1984	July	10	290	11,737	12,027	.0241	.9759	72,162
			11	153	9,896	10,049	.0152	.9848	60,294
		August	7	475	16,177	16,652	.0285	.9715	99,912
			8	1,247	20,706	21,953	.0568	.9432	131,718
Totals		n = 4		2,165	58,516	60,681	.0357	.9643	364,086
Mean				541.3	14,629	15,170.3	.0357	.9643	91,022
Overall Totals		n = 27		3,741	95,541	99,282	.0377	.9623	595,692
Mean				138.6	3,538.6	3,677.1	.0377	.9623	22,063

Appendix Table A3. Estimates of daily sockeye salmon escapement past Igiugig (Kvichak River) and Newhalen River (RM 22), 1980.

			Kvichak River (Igiugig)[1/]				Newhalen River - RM 22				
			Daily	Cumulative	Percent of total		Daily	Cumulative	Percent of total		Percent of
Calendar		Julian	count (1)	count (2)	Daily (3)	Cumulative (4)	count (5)	count (6)	Daily (7)	Cumulative (8)	Igiugig (6÷2 x 100)
June	22	174	4,446	4,446	.02	.02					
	23	175	1,644	6,090	.01	.03					
	24	176	840	6,930	.00	.03					
	25	177	480	7,410	.00	.03					
	26	178	450	7,860	.00	.03					
	27	179	148,122	155,982	.66	.69					
	28	180	825,480	981,462	3.67	4.36					
	29	181	1,090,650	2,072,112	4.85	9.21					
	30	182	1,006,020	3,078,132	4.47	13.68	3,000	3,000	.20	.20	.10
July	1	183	1,355,130	4,433,262	6.02	19.70	10,302	13,302	.69	.89	.30
	2	184	1,520,382	5,953,644	6.76	26.45	31,086	44,388	2.07	2.95	.75
	3	185	1,360,860	7,314,504	6.05	32.50	52,596	96,984	3.50	6.45	1.33
	4	186	1,847,400	9,161,904	8.21	40.71	69,612	166,596	4.63	11.08	1.82
	5	187	1,567,500	10,729,404	6.97	47.68	61,230	227,826	4.07	15.16	2.12
	6	188	1,536,300	12,265,704	6.83	54.50	61,476	289,302	4.09	19.25	2.36
	7	189	1,334,820	13,600,524	5.93	60.43	84,594	373,896	5.63	24.88	2.75
	8	190	1,413,720	15,014,244	6.28	66.71	73,668	447,564	4.90	29.78	3.19
	9	191	1,310,760	16,325,004	5.82	72.54	59,286	506,850	3.94	33.72	3.10
	10	192	1,105,380	17,430,384	4.91	77.45	34,020	540,870	2.26	35.99	3.10
	11	193	1,078,140	18,508,524	4.79	82.24	36,492	577,362	2.43	38.42	3.12
	12	194	906,780	19,415,304	4.03	86.27	23,910	601,272	1.59	40.01	3.10
	13	195	852,780	20,268,084	3.79	90.06	36,432	637,704	2.42	42.43	3.15
	14	196	616,680	20,884,764	2.74	92.80	29,628	667,332	1.97	44.40	3.20
	15	197	436,278	21,321,042	1.94	94.74	20,874	688,206	1.39	45.79	3.23
	16	198	311,628	21,632,670	1.38	96.12	21,432	709,638	1.43	47.22	3.28
	17	199	230,676	21,863,346	1.02	97.15	11,244	720,882	.75	47.97	3.30
	18	200	183,294	22,046,640	.81	97.96	9,612	730,494	.64	48.61	3.31
	19	201	161,976	22,208,616	.72	98.68	12,462	742,956	.83	49.43	3.35
	20	202	95,328	22,303,944	.42	99.11	12,246	755,202	.81	50.25	3.39
	21	203	52,782	22,356,726	.23	99.34	13,650	768,852	.91	51.16	3.44
	22	204	98,148	22,454,874	.44	99.78	21,540	790,392	1.43	52.59	3.52
	23	205	36,660	22,491,534	.16	99.94	23,430	813,822	1.56	54.15	3.62
	24	206	13,734	22,505,268	.06	100.00	22,812	836,634	1.52	55.67	3.72
	25	207					19,746	856,380	1.31	56.98	3.81
	26	208					19,620	876,000	1.31	58.29	3.89
	27	209					19,110	895,110	1.27	59.56	3.98
	28	210					8,676	903,786	.58	60.14	4.02
	29	211					13,968	917,754	.93	61.07	4.08
	30	212					16,464	934,218	1.10	62.16	4.15
	31	213					8,856	943,074	.59	62.75	4.19
Aug.	1	214					11,280	954,354	.75	63.50	4.24
	2	215					10,956	965,310	.73	64.23	4.29
	3	216					10,308	975,618	.69	64.92	4.34
	4	217					12,558	988,176	.84	65.75	4.39
	5	218					13,188	1,001,364	.88	66.63	4.45
	6	219					15,492	1,016,856	1.03	67.66	4.52
	7	220					13,080	1,029,936	.87	68.53	4.58
	8	221					14,628	1,044,564	.97	69.50	4.64
	9	222					13,170	1,057,734	.88	70.38	4.70
	10	223					23,376	1,081,110	1.56	71.94	4.80
	11	224					16,056	1,097,166	1.07	73.00	4.88
	12	225					16,266	1,113,432	1.08	74.09	4.95
	13	226					2,448	1,115,880	.16	74.25	4.96
	14	227					2,154	1,118,034	.14	74.39	4.97
	15	228					4,170	1,122,204	.28	74.67	4.99
	16	229					4,560	1,126,764	.30	74.97	5.01
	17	230					4,866	1,131,630	.32	75.30	5.03
	18	231					1,812	1,133,442	.12	75.42	5.04
	19	232					1,236	1,134,678	.08	75.50	5.04
	20	233					1,020	1,135,698	.07	75.57	5.05

Appendix Table A3. Estimates of daily sockeye salmon escapement past Igiugig (Kvichak River) and Newhalen River (RM 22), 1980 - continued.

Calendar	Julian	Kvichak River (Igiugig)[1/] Daily count (1)	Kvichak River (Igiugig)[1/] Cumulative count (2)	Kvichak River (Igiugig)[1/] Percent of total Daily (3)	Kvichak River (Igiugig)[1/] Percent of total Cumulative (4)	Newhalen River - RM 22 Daily count (5)	Newhalen River - RM 22 Cumulative count (6)	Newhalen River - RM 22 Percent of total Daily (7)	Newhalen River - RM 22 Percent of total Cumulative (8)	Percent of Igiugig (6÷2 x 100)
21	234					1,410	1,137,108	.09	75.66	5.05
22	235					8,580	1,145,688	.57	76.23	5.09
23	236					7,266	1,152,954	.48	76.72	5.12
24	237					9,216	1,162,170	.61	77.33	5.16
25	238					8,136	1,170,306	.54	77.87	5.20
26	239					8,988	1,179,294	.60	78.47	5.24
27	240					7,542	1,186,836	.50	78.97	5.27
28	241					13,968	1,200,804	.93	79.90	5.34
29	242					19,770	1,220,574	1.32	81.21	5.42
30	243					24,372	1,244,946	1.62	82.84	5.53
31	244					21,312	1,266,258	1.42	84.25	5.63
Sept. 1	245					14,766	1,281,024	.98	85.24	5.69
2	246					12,684	1,293,708	.84	86.08	5.75
3	247					14,868	1,308,576	.99	87.07	5.81
4	248					20,508	1,329,084	1.36	88.43	5.91
5	249					27,666	1,356,750	1.84	90.28	6.03
6	250					26,340	1,383,090	1.75	92.03	6.15
7	251					30,642	1,413,732	2.04	94.07	6.28
8	252					23,458	1,437,190	1.56	95.63	6.39
9	253					16,274	1,453,464	1.08	96.71	6.46
10	254					9,090	1,462,554	.60	97.32	6.50
11	255					8,550	1,471,104	.57	97.88	6.54
12	256					6,840	1,477,944	.46	98.34	6.57
13	257					4,296	1,482,240	.29	98.63	6.59
14	258					3,186	1,485,426	.21	98.84	6.60
15	259					3,222	1,488,648	.21	99.05	6.61
16	260					2,766	1,491,414	.18	99.24	6.63
17	261					4,398	1,495,812	.29	99.53	6.65
18	262					2,790	1,498,602	.19	99.71	6.66
19	263					1,728	1,500,330	.11	99.83	6.67
20	264					792	1,501,122	.05	99.88	6.67
21	265					1,134	1,502,256	.08	99.96	6.68
22	266					414	1,502,670	.03	99.98	6.68
23	267					54	1,502,724	.01	99.99	6.68
24	268					174	1,502,898	.01	100.00	6.68
Totals		22,505,268	22,505,268	100.00	100.00	1,502,898	1,502,898	100.00	100.00	6.68

[1/]Data source: ADF&G 1980 Bristol Bay Annual Management Report, p.71.

Appendix Table A3. Continued - 1981.

Calendar		Julian	Kvichak River (Igiugig)[1/] Daily count (1)	Kvichak River (Igiugig)[1/] Cumulative count (2)	Kvichak River (Igiugig)[1/] Percent of total Daily (3)	Kvichak River (Igiugig)[1/] Percent of total Cumulative (4)	Newhalen River - RM 22 Daily count (5)	Newhalen River - RM 22 Cumulative count (6)	Newhalen River - RM 22 Percent of total Daily (7)	Newhalen River - RM 22 Percent of total Cumulative (8)	Percent of Igiugig (6÷2 x 100)
June	17	169	0	0	.00	.00					
	18	170	0	0	.00	.00					
	19	171	108	108	.01	.01					
	20	172	366	474	.02	.03					
	21	173	228	702	.01	.04					
	22	174	4,020	4,722	.23	.27					
	23	175	16,950	21,672	.97	1.24					
	24	176	7,632	29,304	.43	1.67					
	25	177	3,696	33,000	.21	1.88					
	26	178	1,572	34,572	.09	1.97					
	27	179	582	35,154	.03	2.00					
	28	180	1,050	36,204	.06	2.06	30	30	.01	.01	.08
	29	181	32,238	68,442	1.84	3.90	60	90	.03	.04	.13
	30	182	47,814	116,256	2.73	6.63	84	174	.04	.08	.15
July	1	183	140,502	256,758	8.01	14.64	114	288	.05	.13	.11
	2	184	181,512	438,270	10.35	24.99	138	426	.06	.19	.10
	3	185	38,802	477,072	2.21	27.20	168	594	.07	.26	.12
	4	186	58,566	535,638	3.34	30.54	192	786	.08	.34	.15
	5	187	299,322	834,960	17.06	47.60	1,206	1,992	.52	.86	.24
	6	188	191,088	1,026,048	10.89	58.49	2,652	4,644	1.14	2.00	.45
	7	189	36,396	1,062,444	2.07	60.56	3,510	8,154	1.51	3.51	.77
	8	190	30,576	1,093,020	1.74	62.30	3,204	11,358	1.38	4.89	1.04
	9	191	120,684	1,213,704	6.88	69.18	3,276	14,634	1.41	6.30	1.21
	10	192	286,428	1,500,132	16.33	85.51	3,624	18,258	1.56	7.86	1.22
	11	193	175,344	1,675,476	9.99	95.50	3,642	21,900	1.57	9.43	1.31
	12	194	28,914	1,704,390	1.65	97.15	2,802	24,702	1.21	10.64	1.45
	13	195	19,116	1,723,506	1.09	98.24	4,194	28,896	1.81	12.45	1.68
	14	196	7,476	1,730,982	.43	98.67	11,106	40,002	4.79	17.24	2.31
	15	197	3,192	1,734,174	.18	98.85	6,648	46,650	2.87	20.11	2.69
	16	198	9,606	1,743,780	.55	99.40	7,914	54,564	3.42	23.53	3.13
	17	199	5,178	1,748,958	.29	99.69	9,780	64,344	4.22	27.75	3.68
	18	299	1,410	1,750,368	.08	99.77	9,702	74,046	4.19	31.94	4.23
	19	201	3,990	1,754,358	.23	100.00	16,524	90,570	7.13	39.07	5.16
	20	202					20,226	110,796	8.73	47.80	6.32
	21	203					23,880	134,676	10.32	58.12	7.68
	22	204					21,090	155,766	9.10	67.22	8.88
	23	205					17,328	173,094	7.48	74.70	9.87
	24	206					13,260	186,354	5.72	80.42	10.62
	25	207					9,198	195,552	3.97	84.39	11.15
	26	208					10,236	205,788	4.42	88.81	11.73
	27	209					10,128	215,916	4.37	93.18	12.31
	28	210					7,206	223,122	3.11	96.29	12.72
	29	211					2,544	225,666	1.10	97.39	12.86
	30	212					2,112	227,778	.91	98.30	12.98
	31	213					834	228,612	.36	98.66	13.03
Aug.	1	214					1,326	229,938	.57	99.23	13.11
	2	215					996	230,934	.43	99.66	13.16
	3	216					444	231,378	.19	99.85	13.19
	4	217					336	231,714	.15	100.00	13.21
Totals			1,754,358	1,754,358	100.00	100.00	231,714	231,714	100.00	100.00	13.21

[1/]Data source: ADF&G final daily escapement counts provided by Henry Yuen, 3 February 1982.

Appendix Table A3. Continued - 1982.

Calendar		Julian	Kvichak River (Igiugig)[1/] Daily count (1)	Kvichak River (Igiugig)[1/] Cumulative count (2)	Kvichak River (Igiugig)[1/] Percent of total Daily (3)	Kvichak River (Igiugig)[1/] Percent of total Cumulative (4)	Newhalen River - RM 22 Daily count (5)	Newhalen River - RM 22 Cumulative count (6)	Newhalen River - RM 22 Percent of total Daily (7)	Newhalen River - RM 22 Percent of total Cumulative (8)	Percent of Igiugig (6÷2 x 100)
June	21	173	0	0	.00	.00					
	22	174	30	30	.00	.00					
	23	175	12	42	.00	.00					
	24	176	18	60	.00	.01					
	25	177	0	60	.00	.01					
	26	178	6	66	.00	.01					
	27	179	0	66	.00	.01					
	28	180	12	78	.00	.01					
	29	181	18	96	.00	.01					
	30	182	18	114	.00	.01					
July	1	183	8,460	8,574	.75	.76					
	2	184	6,306	14,880	.56	1.31					
	3	185	1,398	16,278	.12	1.43					
	4	186	9,066	25,344	.80	2.23	0	0	.00	.00	.00
	5	187	5,658	31,002	.50	2.73	0	0	.00	.00	.00
	6	188	15,102	46,104	1.33	4.06	0	0	.00	.00	.00
	7	189	92,112	138,216	8.12	12.18	0	0	.00	.00	.00
	8	190	282,342	420,558	24.88	37.06	0	0	.00	.00	.00
	9	191	130,500	551,058	11.50	48.56	480	480	.33	.33	.09
	10	192	47,262	598,320	4.16	52.72	1,074	1,554	.73	1.06	.26
	11	193	32,286	630,606	2.84	55.57	4,332	5,886	2.94	4.00	.93
	12	194	49,086	679,692	4.33	59.89	6,306	12,192	4.28	8.28	1.79
	13	195	17,220	696,912	1.52	61.41	3,774	15,966	2.56	10.84	2.29
	14	196	9,378	706,290	.83	62.24	2,208	18,174	1.50	12.34	2.57
	15	197	6,738	713,028	.55	62.83	1,734	19,908	1.18	13.52	2.79
	16	198	96,768	809,796	8.53	71.36	2,058	21,966	1.40	14.91	2.71
	17	199	112,752	922,548	9.94	81.29	3,528	25,494	2.40	17.31	2.76
	18	200	59,202	981,750	5.22	86.51	864	26,358	.59	17.83	2.68
	19	201	93,876	1,075,626	8.27	94.78	1,050	27,408	.71	18.61	2.55
	20	202	38,994	1,114,620	3.44	98.22	3,258	30,666	2.21	20.82	2.75
	21	203	2,394	1,117,014	.21	98.43	5,322	35,988	3.61	24.43	3.22
	22	204	1,734	1,118,748	.15	98.58	4,482	40,470	3.04	27.48	3.62
	23	205	1,248	1,119,996	.11	98.69	3,456	43,326	2.35	29.82	3.92
	24	206	3,576	1,123,572	.32	99.01	1,896	45,822	1.29	31.11	4.08
	25	207	5,916	1,129,488	.52	99.53	1,380	47,202	.94	32.05	4.18
	26	208	4,392	1,133,880	.39	99.92	1,422	48,624	.97	33.01	4.29
	27	209	906	1,134,840	.08	100.00	4,086	52,710	2.77	35.79	4.64
	28	210					5,292	58,002	3.59	39.38	5.11
	29	211					3,594	61,596	2.44	41.82	5.52
	30	212					7,152	68,748	4.86	46.67	6.06
	31	213					8,568	77,316	5.82	52.49	6.81
Aug.	1	214					15,498	92,814	10.52	63.01	8.18
	2	215					12,966	105,780	8.80	71.82	9.32
	3	216					11,640	117,420	7.90	79.72	10.35
	4	217					10,896	128,316	7.40	87.12	11.31
	5	218					5,448	133,764	3.70	90.81	11.79
	6	219					5,394	139,158	3.66	94.48	12.26
	7	220					3,654	142,812	2.48	96.96	12.58
	8	221					1,470	144,282	1.00	97.96	12.71
	9	222					1,080	145,362	.73	98.69	12.81
	10	223					1,302	146,664	.88	99.57	12.92
	11	224					282	146,946	.19	99.76	12.95
	12	225					348	147,294	.24	100.00	12.98
Totals			1,134,840	1,134,840	100.00	100.00	147,294	147,294	100.00	100.00	12.98

[1/] Data source: Kvichak River final daily escapement counts provided by Dick Russell, ADF&G Commercial Fish Division, King Salmon office, 6 December 1982.

Appendix Table A3. Continued - 1983.

Calendar		Julian	Kvichak River (Igiugig)[1/] Daily count (1)	Kvichak River (Igiugig)[1/] Cumulative count (2)	Kvichak River (Igiugig)[1/] Percent of total Daily (3)	Kvichak River (Igiugig)[1/] Percent of total Cumulative (4)	Newhalen River - RM 22 Daily count (5)	Newhalen River - RM 22 Cumulative count (6)	Newhalen River - RM 22 Percent of total Daily (7)	Newhalen River - RM 22 Percent of total Cumulative (8)	Percent of Igiugig (6÷2 x 100)
June	20	172	66	66							
	21	173	150	216	.00	.00					
	22	174	174	390	.00	.01					
	23	175	54	444	.00	.01					
	24	176	48	492	.00	.01					
	25	177	6	498	.00	.01					
	26	178	6	504	.00	.01					
	27	179	2,628	3,132	.07	.09					
	28	180	139,062	142,194	3.90	3.98	0	0	.00	.00	.00
	29	181	378,324	520,518	10.60	14.58	6	6	.00	.00	.00
	30	182	422,922	943,440	11.85	26.43	0	6	.00	.00	.00
July	1	183	422,352	1,365,792	11.83	38.26	0	6	.00	.00	.00
	2	184	316,806	1,682,598	8.87	47.13	18	24	.00	.00	.00
	3	185	96,084	1,778,682	2.69	49.82	9,858	9,882	1.40	1.41	.56
	4	186	86,694	1,865,376	2.43	52.25	18,210	28,092	2.59	4.00	1.51
	5	187	99,576	1,964,952	2.79	55.04	34,854	62,046	4.96	8.96	3.20
	6	188	46,890	2,011,842	1.31	56.35	40,014	102,960	5.69	14.65	5.12
	7	189	42,204	2,054,046	1.18	57.54	41,376	144,336	5.89	20.54	7.03
	8	190	155,844	2,209,890	4.37	61.90	29,844	174,180	4.25	24.78	7.88
	9	191	349,170	2,559,060	9.78	71.68	18,624	192,084	2.65	27.43	7.51
	10	192	95,220	2,654,280	2.67	74.35	14,670	207,474	2.09	29.52	7.02
	11	193	31,884	2,686,164	.89	75.24	16,104	223,578	2.29	31.81	8.32
	12	194	48,990	2,735,154	1.37	76.62	30,246	253,824	4.30	36.12	9.28
	13	195	54,708	2,789,862	1.53	78.15	26,472	280,296	3.77	39.88	10.05
	14	196	63,336	2,853,198	1.77	79.92	44,850	325,146	6.38	46.26	11.40
	15	197	341,754	3,194,952	9.57	89.49	27,852	352,998	3.96	50.23	11.05
	16	198	222,414	3,417,366	6.23	95.73	19,836	372,834	2.82	53.05	10.31
	17	199	29,346	3,446,712	.82	96.55	23,724	396,558	3.38	56.43	11.51
	18	200	39,834	3,486,546	1.12	97.66	10,320	406,878	1.47	57.89	11.67
	19	201	52,686	3,539,232	1.48	99.14	10,608	417,486	1.51	59.40	11.80
	20	202	19,266	3,558,498	.54	99.68	17,694	435,180	2.52	61.92	12.23
	21	203	6,138	3,564,636	.17	99.85	17,274	452,454	2.46	64.38	12.69
	22	204	4,170	3,568,806	.12	99.97	9,870	462,324	1.40	65.78	12.95
	23	205	1,176	3,569,982	.03	100.00	11,874	474,198	1.69	67.47	13.28
	24	206					10,920	485,118	1.55	69.03	13.59
	25	207					8,232	493,350	1.17	70.20	13.82
	26	208					15,090	508,440	2.15	72.35	14.24
	27	209					14,400	522,840	2.05	74.39	14.65
	28	210					18,840	541,680	2.68	77.08	15.17
	29	211					23,826	565,506	3.39	80.47	15.84
	30	212					25,518	591,024	3.63	84.10	16.56
	31	213					19,188	610,212	2.73	86.83	17.09
Aug.	1	214					14,334	624,546	2.04	88.87	17.49
	2	215					13,422	637,968	1.91	90.78	17.87
	3	216					15,504	653,472	2.21	92.98	18.30
	4	217					13,692	667,164	1.95	94.83	18.69
	5	218					13,212	680,376	1.88	96.81	19.06
	6	219					6,432	686,808	.92	97.73	19.24
	7	220					9,378	696,186	1.33	99.06	19.50
	8	221					684	696,870	.10	99.16	19.52
	9	222					1,176	698,046	.17	99.32	19.55
	10	223					1,452	699,498	.21	99.53	19.59
	11	224					1,206	700,704	.17	99.70	19.63
	12	225					1,392	702,096	.20	99.90	19.67
	13	226					696	702,792	.10	100.00	19.69
Totals			3,569,982	3,569,982	100.00	100.00	702,792	702,792	100.00	100.00	19.69

[1/]Data source: ADF&G Annual Management Report 1983, Bristol Bay area, March 1984, Table 18, p. 81.

Appendix Table A4. Daily estimates of sockeye salmon escapement Kvichak River (Igiugig) and daily 10-hour index of escapement Newhalen River (RM 1), 1979.

Date		Kvichak River (Igiugig)[1]		Newhalen River - RM 1 10h Index[2]		
		Daily	Cumulative	Daily 10h	Cumulative 10h	% of Igiugig
Calendar	Julian	count (1)	count (2)	index (3)	index (4)	(4÷2x100)
June 20	172	696	696			
21	173	498	1,194			
22	174	612	1,806			
23	175	396	2,202			
24	176	222	2,424			
25	177	356,430	358,854			
26	178	686,868	1,045,722	[23,034][3]	23,034	2.20
27	179	850,170	1,895,892	[52,866]	75,900	4.00
28	180	887,382	2,783,274	[93,150]	169,050	6.07
29	181	1,015,079	3,798,348	75,804	244,854	6.45
30	182	975,168	4,773,516	130,770	375,624	7.87
July 1	183	557,016	5,330,532	131,394	507,018	9.51
2	184	585,012	5,915,544	153,354	660,372	11.16
3	185	925,692	6,841,236	101,358	761,730	11.13
4	186	640,218	7,481,454	264,168	1,025,898	13.71
5	187	492,762	7,974,216	184,230	1,210,128	15.18
6	188	486,090	8,460,306	218,808	1,428,936	16.89
7	189	667,410	9,127,716	179,862	1,608,798	17.63
8	190	573,660	9,701,376	56,994	1,665,792	17.17
9	191	446,460	10,147,836	132,606	1,798,398	17.72
10	192	294,828	10,442,664	102,630	1,901,028	18.20
11	193	220,122	10,662,786	134,718	2,035,746	19.09
12	194	107,712	10,770,498	144,294	2,180,040	20.24
13	195	90,576	10,861,074	141,600	2,321,640	21.38
14	196	68,160	10,929,234	72,198	2,393,838	21.90
15	197	76,992	11,006,226	133,356	2,527,194	22.96
16	198	57,696	11,063,922	87,360	2,614,554	23.63
17	199	48,888	11,112,810	79,026	2,693,580	24.24
18	200	38,922	11,151,732	66,720	2,760,300	24.75
19	201	25,614	11,177,346	104,538	2,864,838	25.63
20	202	23,220	11,200,566	112,392	2,977,230	26.58
21	203	10,050	11,210,616	84,246	3,061,476	27.31
22	204	6,468	11,217,084	29,400	3,090,876	27.56
23	205	1,350	11,218,434	20,250	3,111,126	27.73
24	206			21,990	3,133,116	27.93
25	207			53,826	3,186,942	28.41
26	208			46,176	3,233,118	28.82
27	209			28,328	3,261,456	29.07
28	210			41,220	3,302,676	29.44
29	211			36,744	3,339,450	29.77
30	212			24,888	3,364,338	29.99
31	213			20,310	3,384,648	30.17
Aug 1	214					
2	215					
Totals			11,218,434		3,384,648	30.17

[1]Data source: ADF&G 1980 Bristol Bay Annual Management Report, p.83.

[2]Systematic 24-hour counting program began on 29 June. The daily 10-hour index represents the sum of hourly 10-minute counts from left bank (east bank) 08-17h multiplied by six.

[3]Values in brackets [ ] represent daily 10-hour index counts 26-28 June estimated from early run Newhalen Village subsistence catches together with less frequent left bank 10-minute counts.

Appendix Table A4. Continued - 1980.

Date		Kvichak River (Igiugig)[1]		Newhalen River - RM 1 10h Index[2]		
Calendar	Julian	Daily count (1)	Cumulative count (2)	Daily 10h index (3)	Cumulative 10h index (4)	% of Igiugig (4÷2x100)
June 20	172					
21	173					
22	174	4,446	4,446			
23	175	1,644	6,090			
24	176	840	6,930			
25	177	480	7,410			
26	178	450	7,860			
27	179	148,122	155,982			
28	180	825,480	981,462	[4,914][3]	4,914	.50
29	181	1,090,650	2,072,112	[83,064]	87,978	4.25
30	182	1,006,020	3,078,132	48,222	136,200	4.42
July 1	183	1,355,130	4,433,262	64,662	200,862	4.53
2	184	1,520,382	5,953,644	57,318	258,180	4.34
3	185	1,360,860	7,314,504	78,822	337,002	4.61
4	186	1,847,400	9,161,904	80,076	417,078	4.55
5	187	1,567,500	10,729,404	100,638	517,716	4.83
6	188	1,536,300	12,265,704	132,438	650,154	5.30
7	189	1,334,820	13,600,524	192,954	843,108	6.20
8	190	1,413,720	15,014,244	97,914	941,022	6.27
9	191	1,310,760	16,325,004	92,946	1,033,968	6.33
10	192	1,105,380	17,430,384	132,522	1,166,490	6.69
11	193	1,078,140	18,508,524	129,828	1,296,318	7.00
12	194	906,780	19,415,304	51,306	1,347,624	6.94
13	195	852,780	20,268,084	83,706	1,431,330	7.06
14	196	616,680	20,884,764	103,752	1,535,082	7.35
15	197	436,278	21,321,042	82,800	1,617,882	7.59
16	198	311,628	21,632,670	98,598	1,716,480	7.93
17	199	230,676	21,863,346	61,140	1,777,620	8.13
18	200	183,294	22,046,640	53,622	1,831,242	8.31
19	201	161,976	22,208,616	51,426	1,882,668	8.48
20	202	95,328	22,303,944	75,018	1,957,686	8.78
21	203	52,782	22,356,726	50,310	2,007,996	8.98
22	204	98,148	22,454,874	41,424	2,049,420	9.13
23	205	36,660	22,491,534	26,172	2,075,592	9.23
24	206	13,734	22,505,268	60,330	2,135,922	9.49
25	207			35,550	2,171,472	9.65
26	208			53,772	2,225,244	9.89
27	209			66,354	2,291,598	10.18
28	210			42,444	2,334,042	10.37
29	211			48,294	2,382,336	10.59
30	212			51,174	2,433,510	10.81
31	213			29,652	2,463,162	10.94
Aug 1	214			59,610	2,522,772	11.21
2	215					
Totals			22,505,268		2,522,772	11.21

[1]Data source: ADF&G 1980 Bristol Bay Annual Management Report, p.71.

[2]Systematic 24-hour counting program began on 30 June. The daily 10-hour index represents the sum of hourly 10-minute counts from left bank 08-17-h multiplied by six.

[3]Values in brackets [ ] represent 10-hour index counts 28-29 June, estimated from early run Newhalen Village subsistence catches together with less frequent left bank 10-minute counts.

Appendix Table A4. Continued - 1982.

Date		Kvichak River (Igiugig)[1]		Newhalen River - RM 1 10h Index[2]		
Calendar	Julian	Daily count (1)	Cumulative count (2)	Daily 10h index (3)	Cumulative 10h index (4)	% of Igiugig (4÷2x100)
June 20	172					
21	173	0	0			
22	174	30	30			
23	175	12	42			
24	176	18	60			
25	177	0	60	[0]	0	
26	178	6	66	[0]	0	
27	179	0	66	[0]	0	
28	180	12	78	[0]	0	
29	181	18	96	[0]	0	
30	182	18	114	[0]	0	
July 1	183	8,460	8,574	[0]	0	
2	184	6,306	14,880	[0]	0	
3	185	1,398	16,278	[0]	0	
4	186	9,066	25,344	[0]	0	.00
5	187	5,658	31,002	[0]	0	.00
6	188	15,102	46,104	[0]	0	.00
7	189	92,112	138,216	[360]	360	.26
8	190	282,342	420,558	[810]	1,170	.28
9	191	130,500	551,058	[3,264]	4,434	.80
10	192	47,262	598,320	4,752	9,186	1.54
11	193	32,286	630,606	1,680	10,866	1.72
12	194	49,086	679,692	1,770	12,636	1.86
13	195	17,220	696,912	1,884	14,520	2.08
14	196	9,378	706,290	7,962	22,482	3.18
15	197	6,738	713,028	7,728	30,210	4.24
16	198	96,768	809,796	5,190	35,400	4.37
17	199	112,752	922,548	2,418	37,818	4.10
18	200	59,202	981,750	8,094	45,912	4.68
19	201	93,876	1,075,626	7,560	53,472	4.97
20	202	38,944	1,114,620	9,294	62,766	5.63
21	203	2,394	1,117,014	5,046	67,812	6.07
22	204	1,734	1,118,748	3,648	71,460	6.39
23	205	1,248	1,119,996	1,812	73,272	6.54
24	206	3,576	1,123,572	966	74,238	6.61
25	207	5,916	1,129,488	2,124	76,362	6.76
26	208	4,392	1,133,880	2,200	78,582	6.93
27	209	960	1,134,840	2,304	80,886	7.13
28	210			1,710	82,596	7.28
29	211			1,260	83,856	7.39
30	212			1,350	85,206	7.51
31	213			558	85,764	7.56
Aug 1	214			366	86,130	7.59
2	215			462	86,592	7.63
Totals			1,134,840		86,592	7.63

[1]/Data source: ADF&G 1982 Bristol Bay Annual Management Report, Table 19, p.85.

[2]/Systematic daily 10-hour index program began 10 July. Represents the sum of hourly 10-minute counts from left bank 08-17h multiplied by six.

[3]/Values in brackets [ ] represent daily 10-hour index counts 25 June through 9 July estimated from Newhalen Village subsistence catches at the beginning of the run together with less frequent left bank 10-minute counts.

Appendix Table A4. Continued - 1983.

Date		Kvichak River (Igiugig)[1]		Newhalen River - RM 1 10h Index[2]		
Calendar	Julian	Daily count (1)	Cumulative count (2)	Daily 10h index (3)	Cumulative 10h index (4)	% of Igiugig (4÷2x100)
June 20	172	66	66			
21	173	150	216			
22	174	174	390			
23	175	54	444			
24	176	48	492			
25	177	6	498			
26	178	6	504			
27	179	2,628	3,132			
28	180	139,062	142,194	0	0	
29	181	378,324	520,518	372	372	.07
30	182	422,922	943,440	29,106	29,478	3.12
July 1	183	422,352	1,365,792	16,182	45,660	3.34
2	184	316,806	1,682,598	12,450	58,110	3.45
3	185	96,084	1,778,682	16,188	74,298	4.18
4	186	86,694	1,865,376	20,886	95,184	5.10
5	187	99,576	1,964,952	13,608	108,792	5.54
6	188	46,890	2,011,842	11,274	120,066	5.97
7	189	42,204	2,054,046	7,698	127,764	6.22
8	190	155,844	2,209,890	4,362	132,126	5.98
9	191	349,170	2,559,060	3,264	135,390	5.29
10	192	95,220	2,654,280	7,044	142,434	5.37
11	193	31,884	2,686,164	5,850	148,284	5.52
12	194	48,990	2,735,154	7,356	155,640	5.69
13	195	54,708	2,789,862	17,718	173,358	6.21
14	196	63,336	2,853,198	11,940	185,298	6.49
15	197	341,754	3,194,952	8,772	194,070	6.07
16	198	222,414	3,417,366	3,174	197,244	5.77
17	199	29,346	3,446,712	36,012	233,256	6.77
18	200	39,834	3,486,546	20,388	253,644	7.27
19	201	52,686	3,539,232	8,694	262,338	7.41
20	202	19,266	3,558,498	8,358	270,696	7.61
21	203	6,138	3,564,636	9,138	279,834	7.85
22	204	4,170	3,568,806	8,508	288,342	8.08
23	205	1,176	3,569,982	6,726	295,068	8.27
24	206			11,292	306,360	8.58
25	207			3,828	310,188	8.69
26	208			1,806	311,994	8.74
27	209			3,270	315,264	8.83
28	210			5,070	320,334	8.97
29	211			2,334	322,668	9.04
30	212			3,120	325,788	9.13
31	213			1,884	327,672	9.18
Aug 1	214					
2	215					
Totals			3,569,982		327,672	9.18

[1]/Data source: ADF&G Annual Management Report, 1983 Bristol Bay area, March 1984, Table 18, p.81.

[2]/Systematic daily 10-hour index program began 28 June. Represents the sum of hourly 10-minute counts from left bank 08-17h multiplied by six.

Appendix Table B1. Data points[1] used in calculating the regression equation relating water stage elevations (feet) at Newhalen RM 22[2] to RM 16.

1980			1981			1982		
Water stage elevation			Water stage elevation			Water stage elevation		
Date	RM 22	RM 16	Date	RM 22	RM 16	Date	RM 22	RM 16
8/05	8.96	8.29*	7/02	6.26	6.09*	7/12	5.28	5.27**
8/08	8.70	8.12*	7/20	7.41	6.98*	7/18	5.57	5.48**
8/13	9.45	8.54*	7/22	7.45	7.02*	7/21	5.53	5.45**
8/21	9.88	[9.04][3]	7/24	7.54	7.08*	7/22	5.65	5.54**
8/22	9.75	8.94*	7/25	7.62	7.14*	7/25	6.19	6.00*
8/27	8.62	8.00*	7/31	7.49	7.08*	8/04	6.88	6.67*
8/28	8.42	7.94*	8/15	[8.15]	[7.50][3]	8/07	6.64	6.45*
9/02	7.39	7.02*	9/05	6.26	6.13*	8/08	6.55	6.38*
						8/18	5.94	(5.91**)[4]
	n = 8			n = 8		8/26	5.35	(5.39**)
						9/08	5.54	5.47**
						9/17	6.85	6.46*8
							n = 12	

1983			1984		
Water state elevation			Water stage elevation		
Date	RM 22	RM 16	Date	RM 22	RM 16
6/24	4.36	4.54**	7/02	5.60	5.55**
6/26	4.52	4.68**	7/22	5.60	5.52**
7/04	5.12	5.16**	8/03	5.35	5.28**
7/08	5.16	5.27**	8/06	5.54	5.47**
7/12	5.28	5.31**	8/18	5.56	5.45**
7/15	5.31	5.34**	8/22	5.59	5.51**
8/15	5.50	5.49**	9/02	5.71	5.50**
			9/16	4.06	4.18**
	n = 7			n = 8	

Regression equation:

$$Y = .9759 + .8143(X) \quad (R^2 = .9977)$$

where: X = RM 22 water stage and Y = estimate water stage at RM 16

$$X = \frac{Y-.9759}{.8143} \qquad Y = .9759 + .8143(X)$$

[1] Data points where RM 16 water stage elevations were below 6 feet in 1980 and 1981 are not included as Dames & Moore personnel determined that river was not communicating accurately with stilling well below approximately 6 foot water stage elevation. USGS personnel installed continuous recording Stacom manometer gauge during early May 1982.

[2] Water stage elevations at RM 22 standardized to datum established in 1980.

[3] Values in brackets [ ] represent maximum water stage elevations from high water marks on staff gauges from RM 16 and RM 22.

[4] Values in (**) represent values for manometer estimated from relationship of readings of water stage elevations less than 6 feet from manometer and stilling well RM 16, 1982-1984 (See Appendix Table B2).

*Represents staff gauge readings in stilling well.
**Represents readings from manometer.

Appendix Table B2. Data points used in calculating the regression equation[1/] relating readings of water stage elevation below 6 feet from staff gauge in stilling well to manometer gauge, Newhalen RM 16 USGS gauging station, 1982-1984.

1982			1983			1984		
Water stage elevation			Water stage elevation			Water stage elevation		
Date	Well	Recorder	Date	Well	Recorder	Date	Well	Recorder
9/08	5.50	5.47	6/26	4.83	4.68	6/17	4.08	4.02
	n = 1		7/04	5.25	5.16	6/30	5.46	5.44
			7/08	5.30	5.27	7/02	5.56	5.55
			7/12	5.34	5.31	8/06	5.51	5.47
			7/15	5.38	5.34	8/18	5.54	5.45
			8/15	5.53	5.49	8/22	5.53	5.51
			9/24	3.38	3.06	9/02	5.57	5.50
				n = 7		9/16	4.24	4.18
							n = 8	

[1/] Regression equation:

$$Y = -.5093 + 1.0860(X) \qquad R^2 = .9950$$

where: X = Readings of water stage elevation of staff gauge in stilling well.

Y = Gauge readings of water stage elevation of manometer gauge in house.

$$X = \frac{Y-(-.5093)}{1.0860}$$

Appendix Table B3. Standardized water stage elevation and discharge information from FRI and Dames & Moore studies conducted at Newhalen RM 22, 1980-1984.

Date		1980			1981			1982		
		Water stage Elevation (ft)		RM 16 discharge[3]	Water stage Elevation (ft)		RM 16 discharge[3]	Water stage Elevation (ft)		RM 16 discharge[3]
Calendar	Julian	RM 22[1]	RM 16[2]	(cfs)	RM 22[1]	RM 16[2]	(cfs)	RM 22[1]	RM 16[2]	(cfs)
Jun 28	180					5.87*	19,592			
29	181									
30	182									
Jul 1	183				6.26	6.09*	20,374			
2	184				6.26	6.09*	20,604			
3	185				6.21	6.03	20,328	5.28	5.28*	16,942
4	186	(7.20)	(6.84)[4]	24,304	6.16	5.99	20,144	5.20	5.21	16,634
5	187				6.03	5.89	19,684	5.03	5.07	16,021
6	188				6.07	5.82	19,822	5.03	5.07	16,021
7	189				6.05	5.90	19,730	4.93	4.99	15,677
8	190				6.04	5.89	19,684	4.93	4.99	15,677
9	191				6.14	5.98	20,098	5.02	5.06	15,978
10	192	(8.00)	(7.49)	27,250	6.27	6.08	20,558	5.08	5.11	16,238
11	193				6.37	6.16	20,926	5.20	5.21	16,634
12	194				6.55	6.31	21,617	5.28	5.27*	16,898
13	195				6.67	6.41	22,087	5.37	5.35	17,250
14	196				6.76	6.48	22,416	5.41	5.38	17,382
15	197	(8.55)	(7.94)	29,500	6.89	6.59	22,933	5.45	5.41	17,515
16	198				7.01	6.68	23,356	5.48	5.44	17,650
17	199				7.10	6.76	23,732	5.54	5.49	17,875
18	200				7.25	6.88	24,304	5.57	5.48*	17,830
19	201				7.35	6.96	24,688	5.55	5.50	17,920
20	202				7.41	6.98*	24,784	5.54	5.49	17,875
Jul 21	203				7.46	7.06	25,168	5.53	5.45*	17,695
22	204				7.45	7.02*	24,976	5.65	5.54*	18,100
23	205				7.46	7.06	25,168	5.75	5.66	18,640
24	206				7.54	7.08*	25,264	5.93	5.80	19,270
25	207				7.62	7.14*	25,552	6.19	6.00*	20,190
26	208				7.64	7.20	25,840	6.48	6.25	21,340
27	209				7.67	7.22	25,936	6.66	6.40	22,040
28	210				7.62	7.18	25,744	6.83	6.54	22,698
29	211	9.28	8.54*	32,568	7.57	7.14	25,552	6.87	6.57	22,839
30	212	9.23	8.49	32,308	7.58	7.15	25,600	7.01	6.68	23,356
31	213	9.23	8.49	32,308	7.49	7.08*	25,264	7.11	6.77	23,779
Aug 1	214	9.19	8.46	32,152	7.51	7.09	25,312	7.11	6.77	23,779
2	215	9.17	8.44	32,048	7.67	7.22	25,936	7.08	6.74	23,638
3	216	9.14	8.42	31,944	7.92	7.43	26,950	6.98	6.66	22,980
4	217	9.04	8.34	31,528	7.97	7.47	27,150	6.88	6.67*	23,309
5	218	8.96	8.29*	31,268	7.97	7.47	27,150	6.81	6.52	22,604
6	219	8.84	8.17	30,650	7.97	7.47	27,150	6.68	6.42	22,134
7	220	8.79	8.13	30,450	7.97	7.47	27,150	6.64	6.45*	22,275
8	221	8.70	8.12*	30,400				6.55	6.38*	21,946
9	222	8.65	8.02	29,900				6.44	6.22	21,202
10	223	8.66	8.03	29,950				6.33	6.13	20,788
11	224	8.84	8.17	30,650				6.36	6.15	20,880
12	225	9.18	8.45	32,100		7.49*	27,250	6.27	6.08	20,558
13	226	9.45	8.64*	33,088				6.20	6.02	20,282
14	227	9.47	8.69	33,348				6.10	5.94	19,914
15	228	9.42	8.65	33,140	8.15**	7.50*	27,300	6.08	5.93	19,868
16	229	9.38	8.61	32,932				6.03	5.89	19,684
17	230	9.35	8.59	32,828		7.40*	26,800	6.01	5.87	19,592
18	231	9.35	8.59	32,828				5.94	5.91*	19,730
19	232	9.68	8.86	34,244		7.25*	26,080	5.86	5.75	19,045
20	233	9.87	9.01	35,054				5.76	5.67	18,685

Appendix Table B3. - continued.

Date		1980			1981			1982		
		Water stage Elevation (ft)		RM 16 discharge[3]	Water stage Elevation (ft)		RM 16 discharge[3]	Water stage Elevation (ft)		RM 16 discharge[3]
Calendar	Julian	RM 22[1]	RM 16[2]	(cfs)	RM 22[1]	RM 16[2]	(cfs)	RM 22[1]	RM 16[2]	(cfs)
Aug 21	234	9.88	9.04*	35,216				5.66	5.58	18,280
22	235	9.75	8.94*	34,676	7.15	6.80	23,920	5.58	5.52	18,010
23	236	9.55	8.75	33,660				5.51	5.46	17,740
24	237	9.36	8.60	32,880		7.08*	25,264	5.45	5.41	17,515
25	238	9.12	8.40	31,840				5.40	5.37	17,338
26	239	8.89	8.22	30,904	6.47	6.24	21,294	5.35	5.43*	17,605
27	240	8.62	8.00*	29,800				5.26	5.26	16,854
28	241	8.42	7.94*	29,500		6.32*	21,664	5.18	5.19	16,546
29	242	8.17	7.63	27,950		6.29*	21,524	5.14	5.16	16,414
30	243	7.93	7.43	26,950				5.18	5.19	16,546
31	244	7.78	7.31	26,368				5.18	5.19	16,546
Sep 1	245	7.57	7.14	25,552				5.16	5.18	16,502
2	246	7.39	7.02*	24,976				5.09	5.12	16,238
3	247	7.20	6.84	24,112				5.04	5.08	16,064
4	248	6.96	6.64	23,168				4.95	5.01	15,763
5	249	6.74	6.46	22,322	6.26	6.13*	20,788	5.15	5.17	16,458
6	250	6.51	6.28	21,478				5.26	5.26	16,854
7	251	6.51	6.28	21,478				5.47	5.43	17,605
8	252	[6.22][5]	6.04	20,374				5.54	5.47*	17,785
9	253	[5.93]	5.80	19,270	5.88	5.76	19,090	5.60	5.54	18,100
10	254	5.64	5.57	18,235				5.64	5.57	18,235
Sep 11	225	5.47	5.43	17,605				5.60	5.54	18,100
12	256	5.37	5.35	17,250				5.65	5.58	18,280
13	257	5.34	5.32	17,118				5.64	5.57	18,235
14	258	5.31	5.30	17,030				5.60	5.54	18,100
15	259	5.36	5.34	17,206				5.80	5.70	18,820
16	260	5.54	5.49	17,875				6.30	6.11	20,696
17	261	5.62	5.55	18,145				6.85	6.46*	22,322
18	262	5.74	5.65	18,595				7.11	6.77	23,779
19	263	5.72	5.63	18,505				7.30	6.92	24,496
20	264	5.70	5.62	18,460				7.42	7.02	24,976
21	265	5.69	5.61	18,415				7.40	7.00	24,880
22	266	5.62	5.55	18,145				7.54	7.12	25,456
23	267	5.51	5.46	17,740				7.52	7.10	25,360
24	268	5.34	5.32	17,118				7.45	7.04	25,072
25	269							7.35	6.96	24,688
26	270							7.18	6.82	24,016
27	271							7.13	6.78	23,826
28	272							7.08	6.74	23,638

Appendix Table B3 - continued.

Date			1983			1984		
			Water stage Elevation (ft)		RM 16 discharge[3]	Water stage Elevation (ft)		RM 16 discharge[3]
Calendar		Julian	RM 22[1]	RM 16[2]	(cfs)	RM 22[1]	RM 16[2]	(cfs)
Jun	8	160					3.12*	8,310
	17	169					4.02*	11,670
	24	176	4.36	4.54*	13,774			
	26	178	4.52	4.66	14,272			
	27	179	4.64	4.75	14,650			
	28	180	4.73	4.84*	15,032			
	29	181	4.82	4.90	15,290			
	30	182	4.88	4.95	15,505		5.44*	17,650
Jul	1	183	4.96	5.01	15,763	5.53	5.48	17,830
	2	184	5.02	5.06	15,978	5.60	5.55*	18,145
	3	185	5.08	5.11	16,194	5.61	5.54	18,100
	4	186	5.10	5.16*	16,414	5.56	5.50	17,920
	5	187	5.11	5.14	16,326	5.60	5.54	18,100
	6	188	5.08	5.11	16,194	5.63	5.56	18,190
	7	189	5.11	5.14	16,326	5.72	5.63	18,505
	8	190	5.16	5.27*	16,898	5.81	5.71	18,865
	9	191	5.24	5.24	16,766	5.87	5.76	19,090
	10	192	5.26	5.26	16,854	5.90	5.78	19,180
	11	193	5.28	5.28	16,942	5.94	5.81	19,316
	12	194	5.28	5.31*	17,074	5.91	5.79	19,225
	13	195	5.26	5.26	16,854	5.89	5.77	19,135
	14	196	5.26	5.26	16,854	5.87	5.76	19,090
	15	197	5.31	5.34*	17,206	5.80	5.70	18,820
	16	198	5.34	5.32	17,118	5.76	5.67	18,685
	17	199	5.36	5.34	17,206	5.63	5.56	18,190
	18	200	5.38	5.36	17,294	5.68	5.60	18,370
	19	201	5.40	5.37	17,338	5.69	5.61	18,415
	20	202	5.36	5.34	17,206	5.69	5.61	18,415
	21	203	5.34	5.32	17,118	5.66	5.58	18,280
	22	204	5.28	5.28	16,942	5.60	5.52*	18,010
	23	205	5.22	5.23	16,722	5.57	5.51	17,965
	24	206	5.14	5.16	16,414	5.56	5.50	17,920
	25	207	5.10	5.13	16,282	5.54	5.49	17,875
	26	208	5.06	5.10	16,150	5.49	5.45	17,695
	27	209	5.00	5.05	15,935	5.46	5.42	17,560
	28	210	4.96	5.01	15,763	5.45	5.41	17,515
	29	211	4.88	4.95	15,505	5.46	5.42	17,560
	30	212	4.86	4.93	15,419	5.47	5.43	17,605
	31	213	4.86	4.93	15,419	5.45	5.41	17,515
Aug	1	214	4.88	4.95	15,505	5.41	5.38	17,382
	2	215	4.86	4.93	15,419	5.36	5.34	17,206
	3	216	4.84	4.92	15,376	5.35	5.28*	16,942
	4	217	4.82	4.90	15,290	5.38	5.36	17,294
	5	218	4.96	5.01	15,763	5.42	5.39	17,426
	6	219	4.99	5.04	15,892	5.54	5.47*	17,740
	7	220	4.99	5.04	15,892	5.60	5.54	18,100
	8	221	5.14	5.16	16,414	5.67	5.59	18,325
	9	222	5.29	5.28	16,942	5.68	5.60	18,370
	10	223	5.50	5.45	17,695	5.71	5.63	18,505
	11	224	5.60	5.54	18,100	5.73	5.64	18,550
	12	225	5.62	5.55	18,145	5.71	5.63	18,505
	13	226	5.64	5.57	18,235	5.66	5.58	18,280
	14	227	5.58	5.52	18,010	5.61	5.54	18,100
	15	228	5.50	5.49*	17,875	5.57	5.51	17,965
	16	229	5.41	5.38	17,382	5.49	5.45	17,695
	17	230				5.46	5.42	17,560
	18	231				5.56	5.45*	17,695
	19	232				5.53	5.48	17,830
	20	233						
	21	234						
	22	235				5.59	5.51*	17,965
	23	236						
	24	237						
	25	238						

Appendix Table B3 - continued.

Date		1983			1984		
		Water stage Elevation (ft)		RM 16 discharge[3]	Water stage Elevation (ft)		RM 16 discharge[3]
Calendar	Julian	RM 22[1]	RM 16[2]	(cfs)	RM 22[1]	RM 16[2]	(cfs)
Aug 26	239						
27	240						
28	241						
29	242						
30	243						
31	244				5.91	5.79	19,225
Sep 1	245				5.83	5.72	18,910
2	246				5.70	5.50*	17,920
3	247						
4	248	3.90	4.15	12,190			
5	249	3.88	4.14	12,150			
6	250						
7	251						
8	252						
9	253						
10	254						
11	255						
12	256						
13	257						
14	258						
15	259						
16	260				4.06	4.18*	12,310
17	261						
18	262						
19	263						
20	264						
21	265						
22	266						
23	267						
24	268		3.06*	8,104			
25	269						
26	270						
27	271		2.89*	7,538			
28	272						
29	273						
30	274						

[1]/Represents standardized river level data for RM 22. Benchmark datum established July 30, 1980, at RM 22.3 on left (SE) bank at 1980 FRI counting station. Benchmark = blazed small (4-inch diameter) spruce tree. Benchmark 0 represents datum of 9.23 ft at RM 22 and is equivalent to 8.50 ft water stage elevation at USGS RM 16 gauging station.

[2]/Estimated water stage elevation at USGS RM 16 gauging station from relationship of RM 22 to RM 16 gauge readings, 1980-1984 (see Appendix Table B2).

[3]/Discharge calculated from USGS rating curve for RM 16.

[4]/1980 values in parentheses ( ) represent hindcast values of water stage elevation derived from later observations and real-time log entries.

[5]/1980 values in square brackets [ ] represent linear estimates between days of observation.

*Represents direct readings of water stage elevation made by either FRI or Dames and Moore personnel at USGS RM 16 gauging station. Readings in 1980 and 1981 are from stilling well, readings in 1982 are from either stilling well or manometer, readings in 1983 and 1984 are from continuous recording manometer (See Appendix Tables B1 and B2).

**Maximum water mark on RM 22 stake when observed 22 August 1981. Assumed maximum river level occurred on 15 August 1981.

Appendix Table B4. Data points used in calculating the regression equation[1/] relating water stage elevations (feet) at Newhalen RM 16 USGS gauging station to relative water stage elevations at RM 6.5.

Year	Date		WSEL RM 16 X	Relative WSEL RM 6.5[2/] Y	Predicted[3/] Y
1980	August	21	[9.04][4/]	[13.45]	12.90
1981	August	15	[7.50]	[11.45]	11.50
1982	May	29	1.95	1.95	1.43
	June	2	2.19	2.45	2.30
		9	3.46	5.45	5.72
		19	4.11	6.45	7.01
	July	10	(5.11)[5/]	8.45	8.63
	August	3	(6.66)	10.95	10.61
		6	(6.42)	10.45	10.34
	September	5	(5.17)	8.45	8.72
		16	(6.11)	9.75	9.97
	October	1	6.75	10.85	10.71
1983	August	15	5.49	9.45	9.17
1984	August	4	[5.36]	8.45	8.99

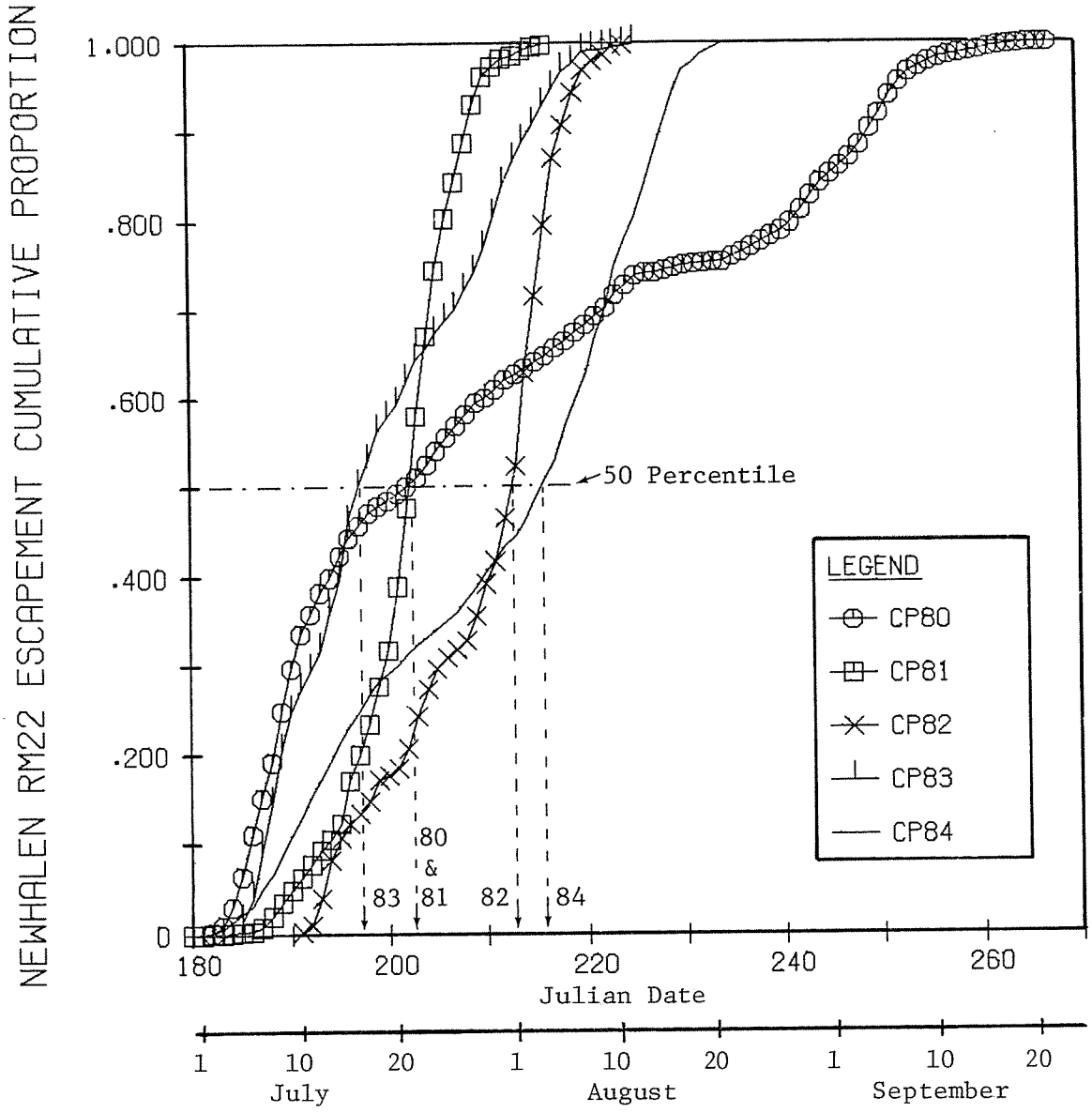
[1/]Regression equation from logarithmic regression
$Y = A + B \ln X = Y = -3.5596 + 7.4746(\ln X)$
$R^2 = .9885$)
where: X = RM 16 water stage elevation and Y = relative estimate of water stage at RM 6.5.

[2/]Staff gauge zero at RM 6.5 = 1.95 ft elevation at RM 16 USGS gauging station. Relative WSEL values for RM 6.5 represent staff gauge readings plus 1.95 ft.

[3/]Values from regression equation $Y = -3.5596 + 7.4746(\ln X)$.

[4/]Values in brackets [ ] represent maximum water stage elevations estimated from high water marks observed on RM 16 staff gauge in stilling well in 1980 and 1981 and on marks on rocks at RM 6.5 measured on 1 June 1982.

[5/]Values in parentheses ( ) estimated from regression equation relating WSEL readings at RM 22 to RM 16 (see Appendix Table B1).


NEWHALEN RM22 ESCAPEMENT CUMULATIVE PROPORTION
1.000
.800
.600
.400
.200
0
50 Percentile
LEGEND
CP80
CP81
CP82
CP83
CP84
80
&
81
83
82
84
180
200
220
240
260
Julian Date
1
10
20
1
10
20
1
10
20
July
August
September