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1982 NEWHALEN RIVER SOCKEYE ESCAPEMENT STUDIES

by

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1.0 ABSTRACT

The escapement of sockeye salmon to spawning areas of the Newhalen River-Lake Clark system above Newhalen RM 22 was estimated by a systematic visual enumeration program for the third consecutive year. The escapement estimate was 147,000, which was 13 percent of the 1982 Kvichak River system escapement of 1.13 million. The timing, pattern, and an index of daily escapement were obtained through a more limited visual enumeration program at RM 1. While the Kvichak River escapement pattern was primarily bimodal, the Newhalen River escapement curve was multimodal. The Newhalen River system received contributions to escapement from all the major segments of the Kvichak escapement, however, the major portion of the Newhalen escapement apparently came from the latter part of the Kvichak escapement. A major portion of the 1982 return to the Newhalen River system, after entering the river, remained for some time before moving upstream past the RM 22 counting station. The peak period of passage at RM 22 corresponded to the summer peak period of river discharge and occurred during rates of discharge ranging from 22,000 to 23,000 cfs.

The majority of the 1982 escapement to the Newhalen River-Lake Clark system came from four-year-old fish from the 1978 spawning. Returns from the 1978 brood year were proportionately greater to the Newhalen River-Lake Clark system than to the Iliamna Lake system and the Kvichak system, as a whole. The Newhalen River contained the largest proportion of 3_2 jacks found in the sampling of Iliamna Lake and Lake Clark spawning grounds. This may indicate a strong return to the Newhalen River in 1983.

The 1982 studies in the Newhalen River-Lake Clark system emphasized the need to examine 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.

KEY WORDS: Newhalen River-Lake Clark system, sockeye salmon, escapement estimation, escapement timing, age composition.

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3.0 INTRODUCTION

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 season and the managers' 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. In some cases this can be accomplished by utilizing the differential timing of races as they pass through the fishery. Some indications of this are provided by recent changes in the sockeye salmon runs to the Newhalen River-Lake Clark system (Figure 1). This system ceased to be a major contributor to Kvichak salmon production in the late 1930s, probably due to overfishing in the early part of the run (1). Recently it has again become an important lake system with strong sockeye salmon runs (2). This reversal was believed to be caused by two factors. First there was a lack of, or reduced, early season commercial harvest by the Bristol Bay commercial fishery. Next, environmental conditions were particularly favorable to salmon survival.

Therefore, since 1979 a major part of our research has been a study of the 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. This report summarizes results of the adult escapement studies conducted in the Newhalen River-Lake Clark system in 1982.

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 1982 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 in 1980 and 1981 (3-5). The enumeration station was located at the site established in 1980 (Figure 2). Visual counts were made from one tree on the right (west) bank and one tree on the left (east) bank over the period July 4 through August 12.

In 1982 migration intensities were low, and fish were generally tallied singly with hand tallies. Polaroid glasses were worn to reduce surface and sun glare, and audible timers were used for precise counting periods.

As in 1980 and 1981, 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 15 days during the course of the run to obtain an estimate of the proportion of daily passage which passed during the 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 interpolated for the time periods missed. To estimate passage during the night period (0000-0400h), or 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 Index of the Escapement to the Lower Newhalen River

4.2.1 Method of Observation

We obtained information on run timing and an index of escapement to the Newhalen River system at RM .75 (generalized as RM 1) just upriver from Newhalen Village (Figure 1). Visual counts were made daily from a 30 ft bluff on the left (east) bank from 0800-1700h (10-hour index) over the period July 9 through August 2. Limited personnel, boats, and equipment prevented more extensive counting operations at this site. Visual counting procedures at RM 1 were the same as followed at RM 22.

4.2.2 Daily Escapement Indexes

The 10-minute left bank counts were multiplied by six to obtain hourly estimates of passage rates. Hourly passage rates were summed over the 10-hour counting period to give a daily index of escapement.

4.3 Stream Survey Index of Escapement

Observations on the timing and distribution of sockeye salmon in the Newhalen River and peak indexes of abundance for the major spawning groups of the Newhalen River-Lake Clark system were determined by aerial surveys conducted on July 10, August 3, 6, and 19, and September 16. Pilot Paul Hornberger of Iliamna Air Taxi and a Cessna 206 on floats, or a Cessna 172 XP on wheels, flew the surveys. FRI observers were P. H. Poe, T. J. James, and C. M. Rawlinson. Observations were recorded on cassette tape recorders and transcribed at a later date.

4.4 Age, Size and Sex Ratio of the Newhalen River Escapement

Except for years having a significant portion of .1-ocean males, the age, size, and sex ratios of the Newhalen River-Lake Clark escapement above RM 22 can be sampled adequately from catches of the Nondalton subsistence fishery (5 and 6). A total of over 800 sockeye salmon caught in the Nondalton subsistence fishery gill nets of commercial net size (5 3/8-inch mesh) were sampled for age, size, and sex ratio on July 14, 18, 20, 23, 28, and August 3, 6, and 9. Fish were measured from mid-eye to tail fork. Otoliths were collected from each fish and were stored in dry coin envelopes for later determinations of age. Scale samples were also taken from fish sampled during the course of the run.

In the laboratory, otoliths from each fish were placed on a black plastic card and covered with a drop of water. Fresh water and marine ages were determined through a binocular dissecting microscope under reflected light. Annuli were determined in accordance with the technique described by Kim and Roberson (7).

A total of over 400 spawners in the Tazimina River and in the vicinity of RM 16 of the Newhalen River were also sampled for otoliths and measured for length whenever practicable. Sex ratios were not recorded during this sampling as differential rates of dying and recovery between males and females occur on the spawning beds and make these ratios difficult to translate into real numbers at time of spawning.

4.5 Climatological and Hydrological Observations

Climatological observations, water temperature, river stage elevation, and turbidity were recorded daily at RM 22. Incident solar radiation was measured daily at our Iliamna facility with an 8-day Belfort Pyrheliometer. Infrequent readings of river stage elevation were also made at the U.S. Geological Survey gauging station at RM 16 and at RM 6.5, where a staff gauge had been placed on May 29 during the spring Dames and Moore juvenile salmon program (8). 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 AND DISCUSSION

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 in the last four years, 1979-1982. 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 run-off, 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. 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.

The 15 days of 24-hour counting conducted during the 1982 Newhalen Rm 22 enumeration showed 4.30 percent of the accumulative daily passage occurring 0000-0400h with a range of 1.4 to 12.3 percent (Table 1). This compares very closely to the results of 6 days of 24-hour counting in 1981 which showed that 4.07 percent of the daily passage occurred 0000-0400h (5). The actual counts for days of 20-hour counts were therefore expanded to 24-hour daily estimates of escapement using the formula:

$$\text{Daily passage} = \text{Total count 0400-2400h} \times 1.0449 \times 6$$

The daily escapement estimates at RM 22 are summarized and compared with the results of the 1982 ADF&G Igiugig tower enumeration program in Table 2. The 1982 Newhalen River escapement estimate of 147,000 above RM 22 was 13.0 percent of the Kvichak River system escapement of 1.13 million, enumerated by ADF&G at Igiugig.

5.2 Index of Escapement RM 1

The daily 10-hour indexes of escapement at RM 1 are summarized and compared with the results of the Igiugig tower enumeration program in Table 3. A total of 7.6 percent and 13.0 percent of the Igiugig escapement were accounted for at the RM 1 site and the RM 22 site, respectively. The RM 1 accumulative total index of 86,600 accounted for 58.8 percent of the RM 22 escapement estimate of 147,000. However, there were considerable numbers of salmon that passed RM 1 that were not counted in the RM 22 enumeration as they spawned in areas of the Newhalen River itself, or in tributaries that entered the Newhalen River below RM 22. Aerial survey information presented later on in this

report indicates that the RM 1 10-hour index accounted for more like 40 percent of the escapement to the Newhalen River-Lake Clark system in 1982.

5.3 Timing and Pattern of Escapement

5.3.1 Kvichak River

The hypothetical 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 (.3008) of the daily Kvichak/Naknek catches and lagged seven days before they were added to the daily Igiugig escapement. The reconstructed 1982 Kvichak run appears bimodal as well as the escapement which however, was more sharply bimodal and came primarily from the late-early and late portions of the run, while the Kvichak/Naknek catch came mainly from the very early and middle portions of the run. Both the catch and total run timing patterns were of course influenced by the Naknek River run, which was larger than the Kvichak run in 1982. Based on escapement timings, it appears that Naknek fish were probably heavily represented in the early-run catch.

5.3.2 Newhalen River

The Kvichak River pattern of escapement is compared to the Newhalen River escapement curve at RM 1 and RM 22 in Figure 4. While the Kvichak River escapement pattern is bimodal, the Newhalen RM 1 and RM 22 escapement curves are multimodal which is to be expected when the salmon are approaching their spawning grounds. Although the escapement patterns 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 major portion of the Newhalen run apparently came from the latter part of the Kvichak escapement.

The travel time from Igiugig to the Newhalen RM 1 and RM 22 enumeration sites can be examined in Figure 5. Generally the timing of the escapement pattern at the RM 1 index site lagged back two days corresponds closely to the Igiugig escapement pattern. The straight line distance from Igiugig to the Newhalen River is approximately 50 miles, 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 generally indicates a 4-day lag through July 22, after which a major run occurred at RM 22 that does not seem to correspond to any late season peak at Igiugig.

Comparison of the Newhalen RM 1 escapement curve to the escapement pattern at RM 22 (Figure 6) generally indicates a 2-day lag through July 25, after which a major run occurred at RM 22 that does not at first appear to correspond to any late season peak at RM 1. A closer examination of the RM 1 and RM 22 escapement curves shows that up until July

25, the daily 10-hour indexes of escapement at RM 1 totaled more fish than the 24-hour escapement counts at RM 22. A reasonable explanation for this seems to be that a major portion of the 1982 salmon return to the Newhalen River system, after entering the river, remained for some time before moving upstream past the RM 22 counting station. Furthermore, as 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 for the segregation of the different spawning components of the Newhalen River-Lake Clark system in the Kvichak run.

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 4. The Newhalen River generally remained clear with excellent visibility during the salmon enumeration program, except for several days when rain and wind-generated wave action caused cloudy water. The 1982 escapement curves at RM 1 and RM 22 are shown together with the 1982 and past-mean discharge pattern of the Newhalen River during the period of upstream salmon migration in Figure 7. Peak summer flows in 1982 remained below 24,000 cfs and were the lowest we have observed at the Newhalen RM 22 enumeration site program since our program began in 1980. However, peak annual flows exceeding 25,000 cfs occurred later on in September (Appendix A.1).

In 1982, the period of peak salmon passage at RM 22 corresponded to the greatest rate of increasing summer flows in the Newhalen River (Figure 7). A similar pattern was observed in our 1981 salmon enumeration program at RM 22. In both years, the period of peak salmon passage corresponded to the period of the greatest rate of change in increasing river discharge during te period when adult salmon were abundant in the system. Several explanations can be considered. First, this may suggest that some river discharge rates below approximately 20,000 cfs may delay the upstream passage of salmon in certain areas of the rapids more than discharge rates above 20,000 cfs up to some levels greater than approximately 25,000 cfs. Second, increased upstream passage rates of salmon that have entered the Newhalen River may result from a stimulus related to rapidly increasing river discharge. In reference to the latter, 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 (9). Certainly while both of these possible explanations are highly speculative, they do serve to emphasize the need to further study the upstream passage of salmon through the Newhalen River.

The information concerning measurements and changes of river stage elevation at RM 6.5 and RM 16 are summarized in Table 5. The relationship of changes in river stage elevation at RM 6.5 to RM 16 is shown in Figure 8. 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 increment changes in river stage at both locations is indicated. Thus, at lower-to-moderate flows, river stage at RM 6.5 and RM 16 is best described by a curvilinear relationship, whereas under conditions of extreme high flows, river stage at RM 6.5 and RM is best described by a linear relationship. It was important to obtain this information about hydrological conditions at RM 6.5 because of the prolonged velocity block to salmon passage that occurred there in 1980 (3 and 4).

The information on the relationship between river stage at RM 16 and RM 22 is shown in Figure 9. The data used to derive the linear relationship is contained in Appendix A.2. The direct observations of river stage at RM 16 in 1982 are summarized in Appendix B. Standardized water stage elevation and discharge information from FRI and Dames and Moore studies conducted at RM 22 from 1980-1982 are contained in Appendix A.1. 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.

5.5 Stream Survey Index of Escapement

Peak indices of abundance to individual spawning areas and geographically defined regions of the Kvichak system are summarized in Table 6 and displayed in Figure 10. The Iliamna Lake system received the majority of the escapement, while the Newhalen River-Lake Clark system was up from an average of 8.3 percent for non-peak cycle years to 28.1 percent (Table 7).

Estimates of escapement to spawning areas above RM 22 in 1981 and 1982 represented 13.2 percent and 13.0 percent of the total Kvichak River escapements of 1.75 and 1.13 million, respectively. Whereas the 1982 escapement of 147,000 above RM 22 was only 63.4 percent of the 1982 escapement of 232,000, the index of escapement to areas below RM 22 in 1982 (66,555) was more than four times greater than in 1981 (16,927).

Results of the aerial surveys of the Newhalen River are presented in Table 8. These data show that in 1982 the major portion of Newhalen River spawners entered and remained in the river more than one month before spawning.

Comparison of the percentage of the 1982 Kvichak River escapement that returned to the Newhalen River-Lake Clark system from results of the stream survey and the Newhalen RM 22 enumeration program are presented in Table 9. Noteworthy is that in 1982 the portion of the Kvichak escapement represented by the Newhalen River-Lake Clark system stocks was greater than in 1981 (5). This increase is attributed to the much stronger return to the Newhalen River spawning areas below RM 22 in 1982 even though the portion that returned to spawning areas above Newhalen RM 22 was nearly the same in both years.

5.6 Age, Size and Sex Ratio of the Newhalen River Escapement

Data on the age, size, and sex ratio of sockeye salmon sampled from catches of the Nondalton subsistence fishery are presented in Table 10. A comparison of the age, size, and sex ratio of the Kvichak River and Newhalen RM 22 apportioned escapements grouped as early, middle, and late segments are presented in Tables 11 and 12. The data shows that the size of males and females in the Newhalen Rm 22 escapement were larger than fish sampled from the Kvichak River escapement at Igiugig. The trends in sex ratio are similar with females being proportionately more abundant in the early part of the escapement at both places.

Age composition data collected in the Newhalen River-Lake Clark system summarized by age groups and by brood year are compared to data from the sampling of other selected spawning groups of the Iliamna Lake system and the ADF&G smapling of the Kvichak escapement in Tables 13 and 14. Percentage age composition data by age group and brood year in the Kvichak River escapement are compared to the Iliamna Lake and Newhalen River-Lake Clark system data in Figures 11-14. The data show that the majority of the 1982 escapement to spawning areas of the Newhalen River-Lake Clark system originated from the 1978 brood year. The age group 4_2 represented: 1) 68 percent of the males and 64 percent of the females apportioned in the Newhalen River escapement above RM 22; 2) 81 percent of the males and 92 percent of the females sampled in Tazimina River; and 3) 83 percent of the males and 96 percent of the females sampled in the Newhalen River. However, returns from the 1977 brood year were proportionately less in the Newhalen River-Lake Clark system than in Iliamna Lake, or the Kvichak system as a whole. This corroborates the findings of the age composition of the 1981 Newhalen-Lake Clark escapement in which the 1977 brood stock produced a low percentage of returning spawners 4-years old (5). The small returns in 1981 and 1982 from the 1977 brood year, indicates poor rates of reproduction, possibly due to the delay in migration caused by high Newhalen River discharge rates in 1977. Returns from the 1976 brood year were proportionately higher for Lake Clark spawning areas than other areas sampled in Iliamna Lake and the Newhalen River system.

The abundance of the four major age groups in the 1982 Kvichak and Newhalen River (RM 22) apportioned escapements by sampling period are shown in Figure 15. Although the Newhalen River escapement above RM 22 came from all segments of the Kvichak River escapement, the data indicates that the Newhalen RM 22 escapement came more from the latter portion of the run. However, the validity of this conclusion is confounded by the fact that a major portion of the 1982 return to the Newhalen River-Lake Clark system, after entering the river, remained for some time before moving upstream past the RM 22 counting station.

The deviation in percent of Nondalton from Igiugig age composition represented by the four major age groups by sampling period is shown in Figure 16. For all three sampling periods, the percentage of fish in

age group 4_2 and 6_3 were higher for Nondalton than the Kvichak system as a whole. The opposite was true for age groups 5_2 and 5_3, except for period 3 when the percentage of age 5_3 fish was higher for Nondalton.

The deviation in percent of Nondalton from Igiugig age composition represented by the four major age groups for the period 1962-1982 is shown in Figure 17. These data suggest that Lake Clark has produced a higher proportion of age 2. adult sockeye in the return than the Kvichak system as a whole. Although this may in part be caused by poorer growth of salmon fry in Lake Clark as compared to Iliamna Lake, recent spring smolt studies conducted by Dames and Moore and FRI (8) suggest that some spawning groups of sockeye salmon in the Newhalen River-Lake Clark system have a genetically controlled tendency to smoltify after two years, even when juvenile growth has been very good.

The Newhalen River contained the largest proportion of 3_2 jacks sampled in the Iliamna Lake-Lake Clark area (Tables and Figures 13 and 14). This may indicate a strong return to the Newhalen River in 1983, as few jacks were found above the Newhalen River proper. In the Iliamna Lake system, few jacks were found in the areas sampled. Adequate samples from some areas we routinely visit could not be obtained because of floods and low spawner abundance. However, jacks were either noted, or reported, by residents to be proportionately abundant in some of these areas.

Overall, the spawning ground age composition sampling corresponded closely to the results of the Igiugig sampling of the Kvichak system escapement (Tables 13 and 14, Figures 11 and 12). However, within the system, returns from the 1978 brood year were proportionately stronger to the Newhalen River-Lake Clark component than to the Iliamna Lake component, while the reverse was true for the 1977 brood year. The results corroborate the results of earlier aerial survey and spawning ground sampling programs (5, 10, and 11).

5.7 Discussion

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 that indicate in recent years when Newhalen River-Lake Clark stocks have been a major contributor in the Kvichak run, there has been a tendency for the Newhalen River fish to be strongly represented in the early part of the run (3 and 4).

Therefore, 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 needs to be examined. Studies in these two areas would provide information on what portions of the run are most affected by delays in upstream passage and what portions of the run could be enhanced through selective distribution of commercial fishing pressure in Bristol Bay.

At the present time, no fixed cycle has emerged for the Newhalen River-Lake Clark system, and the regulation of the commercial fishery the next few years (1983-1985) will ultimately determine, or profoundly affect, where the cycle will peak and when the largest escapement should be sought.

In the recent past, the early season commercial harvest in the Naknek-Kvichak district and to the entire Bristol Bay was curtailed by failure to agree on fish prices. Because of the devastating economic damage inflicted upon fishermen and processors alike, it is unlikely that this will happen again under the present hard economic pressure. Manipulation of the timing of escapement can therefore only be achieved by regulation of the harvest periods.

Future research needs concerning sockeye salmon runs to the Newhalen River-Lake Clark system include: 1) continued enumeration of the annual escapement; 2) continued monitoring of the spawning grounds to describe the timing and distribution of runs; 3) continued sampling of the major spawning groups for description of age and size composition; 4) sampling the catches of both the Newhalen and Nondalton subsistence fisheries for age and size composition to determine the arrival and passage times of the different spawning groups; and 5) examination of the assumption that the runs bound for the various spawning areas are uniformly distributed throughout the Kvichak run and thus subjected to equal rates of exploitation by the Bristol Bay commercial fishery.

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Table 1. Proportion of daily upstream passage of sockeye salmon at RM 22 passing 00-04h as determined from actual 10-minute counts for days of 24-hour counting, 1982.

Date		10-minute counts of sockeye salmon				Daily expanded total
		04-24h (1)	00-04h (2)	Daily 00-24h (3)	Proportion (2)÷(3)	(3)x6
July	16	315	28	343	.0816	2,058
	18	130	14	144	.0972	864
	20	513	30	543	.0552	3,258
	21	866	21	887	.0237	5,322
	22	709	38	747	.0501	4,482
	24	295	21	316	.0665	1,896
	25	203	27	230	.1174	1,380
	30	1,140	52	1,192	.0436	7,152
August	1	2,509	74	2,583	.0286	15,498
	2	2,131	30	2,161	.0139	12,966
	3	1,834	106	1,940	.0546	11,640
	4	1,782	34	1,816	.0187	10,896
	5	876	32	908	.0352	5,448
	6	788	111	899	.1235	5,394
	7	568	41	609	.0673	3,654
Totals		14,659	659	15,318	.0430	91,908

Table 2. Daily estimates of sockeye salmon escapement Kvichak River (Igiugig) and Newhalen River (RM 22), 1982.

Date			Igiugig-Kvichak River[1]				Newhalen River - RM 22				
			(1)	(2)	Percent of total		(5)	(6)	Percent of total		Percent of
Calendar		Julian	Daily Count	Accumulative Count	(3) Daily	(4) Accumulative	Daily Count	Accumulative Count	(7) Daily	(8) Accumulative	Igiugig (6÷2x100)
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	960	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
August	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 Commerical Fish Division, King Salmon Office, 6 Dcember 1982.

Table 3. Daily estimates of sockeye salmon escapement Kvichak River (Igiugig) and daily 10-hour index of escapement Newhalen River (RM 1), 1982.

Date			Igiugig-Kvichak River[1]				Newhalen River-RM 1			
			Daily	Accumulative	Percent of Total		Daily 10h[2]	Accumulative	Percent of Total	
Calendar		Julian	Count	Count	Daily	Accumulative	Index Count	Index County	Daily	Accumulative
June	21	173	0	0	.00	.00				
	22	174	30	30	.00	.00				
	23	175	42	42	.00	.00				
	24	176	60	60	.00	.01				
	25	177	60	60	.00	.01	0*	0	.00	.00
	26	178	6	66	.00	.01	0*	0	.00	.00
	27	179	0	66	.00	.01	0*	0	.00	.00
	28	180	12	78	.00	.01	0*	0	.00	.00
	29	181	18	96	.00	.01	0*	0	.00	.00
	30	182	18	114	.00	.01	0*	0	.00	.00
July	1	183	8,460	8,574	.75	.76	0*	0	.00	.00
	2	184	6,306	14,880	.56	1.31	0*	0	.00	.00
	3	185	1,398	16,278	.12	1.43	0*	0	.00	.00
	4	186	9,066	25,344	.80	2.23	0*	0	.00	.00
	5	187	5,658	31,002	.50	2.73	0*	0	.00	.00
	6	188	15,102	46,104	1.33	4.06	0*	0	.00	.00
	7	189	92,112	138,216	8.12	12.18	360*	360	.42	.42
	8	190	282,342	420,558	24.88	37.06	810*	1,170	.94	1.35
	9	191	130,500	551,058	11.50	48.56	3,264*	4,434	3.77	5.12
	10	192	47,262	598,320	4.16	52.72	4,752	9,186	5.49	10.61
	11	193	32,286	630,606	2.84	55.57	1,680	10,866	1.94	12.55
	12	194	49,086	679,692	4.33	59.89	1,770	12,636	2.04	14.59
	13	195	17,220	696,912	1.52	61.41	1,884	14,520	2.18	16.77
	14	196	9,378	706,290	.83	62.24	7,962	22,482	9.19	25.96
	15	197	6,738	713,028	.59	62.83	7,728	30,210	8.92	34.89
	16	198	96,768	809,796	8.53	71.36	5,190	35,400	5.99	40.88
	17	199	112,752	922,548	9.94	81.29	2,418	37,818	2.79	43.67
	18	200	59,202	981,750	5.22	86.51	8,094	45,912	9.35	53.02
	19	201	93,876	1,075,626	8.27	94.78	7,560	53,472	8.73	61.75
	20	202	38,944	1,114,620	3.44	98.22	9,294	62,766	10.73	72.48
	21	203	2,394	1,117,014	.21	98.43	5,046	67,812	5.83	78.31
	22	204	1,734	1,118,748	.15	98.58	3,648	71,460	4.21	82.52
	23	205	1,248	1,119,996	.11	98.69	1,812	73,272	2.09	84.62
	24	206	3,576	1,123,572	.32	99.01	966	74,238	1.12	85.73
	25	207	5,916	1,129,488	.52	99.53	2,124	76,362	2.45	88.19
	26	208	4,392	1,133,880	.39	99.92	2,220	78,582	2.56	90.75
	27	209	960	1,134,840	.08	100.00	2,304	80,886	2.66	93.41
	28	210					1,710	82,596	1.97	95.39
	29	211					1,260	83,856	1.46	96.85
	30	212					1,350	85,206	1.56	98.40
	31	213					558	85,764	.64	99.04
August	1	214					366	86,130	.42	99.67
	2	215					462	86,592	.53	100.00
Totals			1,134,840	1,134,840	100.00	100.00	86,592	86,592	100.00	100.00

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

[2]Systematic daily 10-hour index program began 10 July. Represents hourly 10-minute counts from left bank 08-18h multiplied by six.

*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.

Table 4. Climatological[1] and hydrological observations relevant to Newhalen River escapement studies, 1982.

Date		Sky 0800	Sky 2000	Wind 0800 Mph-Dir	Wind 2000 Mph-Dir	Temperature °Centigrade Air Min	Air Max	Water	Precip. (Inches)	Water Level Ft FRI	Water Level Ft USGS[2]	Discharge[3] (cfs)	Turbidity	Solar Radiation (cal·cm^{-2})
July	3	0	0	--	--	--	--		--	5.28	5.28*	16,942	1	--
	4	3	3	0-0	2-8	--	--	9.0	0.0	5.20	5.22	16,678	1	373
	5	3	2	1-1	5-2	--	23.0	8.7	0.0	5.03	5.08	16,064	1	589
	6	2	3	1-5	1-3	3.0	16.5	9.0	0.0	5.03	5.08	16,064	1	560
	7	3	1	1-3	1-1	10.0	22.0	8.5	0.0	4.93	5.00	15,720	1	665
	8	3	3	2-8	1-8	5.5	18.0	8.5	.06	4.93	5.00	15,720	1	257
	9	3	3	1-1	2-8	7.5	26.0	8.5	0.0	5.02	5.08	16,064	1	647
	10	3	3	0-0	5-5	9.5	24.5	9.0	.04	5.08	5.12	16,238	1	560
	11	3	3	0-0	0-0	9.75	15.0	8.5	.38	5.20	5.22	16,590	1	367
	12	5	3	0-0	1-7	9.5	17.5	8.8	.12	5.28	5.27*	16,898	1	344
	13	-	5	0-0	0-0	9.75	21.3	8.0	0.0	5.37	5.36	17,294	1	332
	14	5	3	0-0	5-2	8.7	12.7	8.4	.04	5.41	5.39	17,426	1	204
	15	3	5	1-2	4-2	3.8	13.0	8.1	.06	5.45	5.43	17,605	1	303
	16	6	3	4-3	4-5	7.0	8.5	7.7	0.2	5.48	5.45	17,695	3	262
	17	3	3	2-5	1-5	6.0	13.8	7.2	T	5.54	5.50	17,920	1	396
	18	3	3	2-7	2-7	5.0	17.7	7.5	T	5.57	5.48*	17,830	1	426
	19	3	1	3-7	3-5	10.8	27.0	9.8	0.0	5.55	5.51	17,965	1	705
	20	1	3	0-0	2-5	5.4	21.7	8.8	0.0	5.54	5.50	17,920	1	513
	21	3	5	0-0	2-5	5.0	17.3	8.2	T	5.53	5.45*	17,695	1	175
	22	5	5	0-0	2-5	13.3	16.2	8.6	T	5.65	5.54*	18,100	1	210
	23	5	3	0-0	2-5	9.0	14.5	7.2	.95	5.75	5.67	18,685	1	233
	24	5	5	0-0	1-5	7.0	13.2	7.2	.28	5.93	5.82	19,362	1	187
	25	5	3	2-3	2-3	8.6	16.7	7.7	.30	6.19	6.00*	20,190	1	484
	26	3	3	0-0	4-4	3.2	23.6	7.6	0.0	6.48	6.26	21,386	2	472
	27	3	4	5-3	0-0	13.4	19.5	7.4	0.0	6.66	6.41	22,087	1	402
	28	3	5	0-0	2-3	9.6	17.6	7.8	T	6.83	6.55	22,745	1	251
	29	3	6	2-3	2-3	9.2	17.2	8.8	.36	6.87	6.58	22,886	1	163
	30	3	2	2-5	1-7	7.9	18.3	8.6	.12	7.01	6.69	23,403	1	344
	31	2	3	1-7	3-7	8.2	15.2	8.3	0.0	7.11	6.77	23,779	1	426
Aug.	1	1	3	3-7	3-7	7.2	15.5	8.5	0.0	7.11	6.77	23,779	1	426
	2	1	1	1-7	1-3	7.5	25.5	9.4	0.0	7.08	6.75	23,685	1	618
	3	1	1	1-3	1-5	1.0	25.5	9.5	0.0	6.98	6.67	23,309	1	595
	4	1	1	0-9	2-3	1.0	22.2	9.5	0.0	6.88	6.67*	23,309	1	595
	5	1	2	3-5	0-9	3.6	--	10.0	0.0	6.81	6.53	22,651	1	554
	6	3	1	0-9	1-5	4.5	21.0	10.0	T	6.68	6.43	22,181	1	542
	7	2	3	0-9	2-5	5.0	19.5	10.0	T	6.64	6.45*	22,275	1	463
	8	2	2	1-5	0-9	5.0	18.0	10.2	T	6.55	6.38*	21,946	1	519
	9	4	3	0-9	3-1	6.8	20.0	10.3	0.0	6.44	6.23	21,248	1	542
	10	5	6	1-5	4-5	8.5	12.9	8.4	.34	6.33	6.14	20,834	1	192
	11	3	3	1-7	0-9	7.5	17.8	9.0	.23	6.36	6.17	20,972	1	472
	12	1	1	0-9	1-5	1.2	20.0	8.4	0.0	6.27	6.09	20,604	1	589
	13	3	6	0-9	0-9	9.5	22.7	9.8	.04	6.20	6.03	20,328	1	344

Sky Code:
1. Cloud cover less than 1/10 of sky
2. Cloud cover less than 1/2 of sky
3. Cloud cover more than 1/2 of sky
4. Fog or thick haze
5. Intermittent rain
6. Continuous rain

T - trace

Wind Direction Code:
1 NE, 2 E, 3 SE, 4 S, 5 SW, 6 W, 7 NW, 8 N, 9 Unknown

Turbidity Code:
1. Clear
2. Light brown
3. Heavily clouded

Wind Velocity Code:

Velocity	Knots
0=Calm	0
1=Light Airs	1-3
2=Light Breeze	4-6
3=Gentle Breeze	7-10
4=Moderate Breeze	11-16
5=Fresh Breeze	17-21

[1] All observations from RM 22 counting station except solar radiation recorded at FRI Iliamna weather station.

[2] Estimated water stage at U. S. Geological survey gage (RM 16) using RM 22 readings and the regression equation: $Y = .9956 + .8128(X)$ ($R^2 = .9975$) where X = FRI RM 22 water stage readings in feet.

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

*Actual readings from U.S. Geological Survey gage at RM 16.

Table 5. Observations of and changes in Newhalen River stage elevations at RM 6.5 and RM 16, 1980-1982.

Date	Newhalen River water Stage elevation (Ft) RM 6.5 (1)	RM 16 (2)	Ratio (2) ÷ (1)	Difference (Ft) (1) - (2)
1982				
May 29	1.95	1.95	(RM 6.5 gage established with 0 = 1.95 ft)	
June 2	2.45	2.19	.89	.26
" 9	5.45	3.46	.63	1.99
" 19	6.45	4.11	.64	2.34
July 10	8.45	[5.12][1/]	.61	3.33
August 3	10.95	[6.67]	.61	4.28
" 6	10.45	[6.43]	.62	4.02
Sept. 5	8.45	[5.14]	.61	3.31
" 16	9.75	[6.12]	.63	3.63
October 1	10.85	6.75	.62	4.10
1981				
August 15	(11.45)[2/]	(7.50)	.66	3.95
1980				
August 21	(13.45)	(9.04)	.67	4.41

[1/] Readings in brackets [] estimated from regression equation relating water stage elevations at RM 22 to RM 16 (see Appendix A.2).

[2/] Readings in parentheses ( ) represent maximum water stage elevations from high water marks observed on RM 16 gage in stilling well in 1980 and 1981, and on rocks at RM 6.5 measured on June 2, 1982.

Table 6. Peak indices of abundance of sockeye salmon to 14 geographic regions of the Kvichak River system in 1982.

Survey Date	Area	1982 index	Percent of total accounted for in 1982 stream surveys
	NW Streams		
8/03	Small streams W. of lower Talarik Creek	925	
8/03	Lower Talarik Creek	19,510	
8/03	Middle Talarik Creek	1,685	
8/03	Upper Talarik Creek	8,235	
8/19	Pete Andrew Creek	2,746	
8/19	Zackar Creek	382	
	TOTAL	33,483	7.86
	Newhalen River System		
8/19	Newhalen River	64,100	
	Lovers Creek	No survey	
9/16	Little Bear Creek and Ponds	150	
8/03	Alexi Creek	0	
8/03	Alexi Lakes	2,275	
8/03	Steam Bath Creek	30	
8/19	Tazimina River	30,740	
8/03	Six Mile Lake Beaches	No survey*	
9/16	Pickerel Lakes	0	
9/16	Pickerel Creek	2	
	TOTAL	97,297	23.12
	Lake Clark		
9/27	Kijik River	2,700	
9/16	Little Kijik River	7,300	
9/16	Kijik Lake Beaches	7,495	
9/16	Kijik Lake Tributaries	1,750	
	Tanalian River	No survey	
9/16	22 Creek	0	
9/16	Sucker Bay Lake	295	
9/27	Lake Clark Beaches	0	
9/27	Currant Creek	0	
9/27	Chokotonk River	20	
9/27	Tlikakila River	1,500	
	Priest Rock Creek and Ponds	No survey	
	TOTAL	21,060	5.00

Table 6. Peak indices of abundance of sockeye salmon to 14 geographic regions of the Kvichak River system in 1982 (continued).

Survey Date	Area	1982 index	Percent of total accounted for in 1982 stream surveys
	NE Streams		
7/30	Roadhouse Creek	188	
8/03	N.W. Eagle Bay Creek	2,965	
8/03	N.E. Eagle Bay Creek and Ponds	5,080	
8/03	Youngs Creek	4,190	
8/03	Chekok Creek and Ponds	370	
8/03	Tomkok Creek	5,000	
8/03	Canyon Creek	1,890	
	Mink Creek	No survey	
8/19	Knutson Creek	325	
	Russian Creek	No survey	
8/19	Pile River	3,560	
	TOTAL	23,568	5.60
	NE Ponds		
9/16	Hudson's Creek and Ponds	15	
8/03	Prince Creek and Ponds	65	
8/03	Canyon Springs	70	
8/03	Wolf Creek Ponds	6	
8/19	Knutson Ponds	0	
8/19	Pedro Creek and Ponds	200	
	TOTAL	356	.09
	Iliamna River System		
8/19	Iliamna River	30,870	
8/19	Bear Creek and Ponds	375	
8/19	False Creek	75	
8/19	Old Williams Creek	275	
8/19	Chinkelyes Creek	4,185	
	TOTAL	35,780	8.50
	SE Streams and Ponds		
8/19	Swamp Creek	50	
8/19	Jack Durand Creek	575	
8/19	Squirrel Village Creeks	825	
8/19	Tommy Creek	835	
8/19	Tommy Springs	325	
	TOTAL	2,610	.62

Table 6. Peak indices of abundance of sockeye salmon to 14 geographic regions of the Kvichak River system in 1982 (continued).

Survey Date	Area		1982 index	Percent of total accounted for in 1982 stream surveys
	Intricate Bay Streams			
8/19	Copper River System		63,035	
	Pope Creek		No survey	
	Nancy Creek		No survey	
8/19	Nick G. Creek		775	
		TOTAL	63,810	15.16
	Gibraltar System			
8/19	Gibraltar Creek (River)		65,940	
8/19	Little Gibraltar Creek		3,490	
	Leon Creek		No survey	
	Trout Creek		No survey	
8/19	Southeast Creek		11,105	
8/19	Dream Creek		6,540	
8/19	Gibraltar Ponds		0	
8/19	Gibraltar Lake Beaches		4,605	
		TOTAL	91,680	21.80
	Kakhonak Bay Streams			
8/19	Nick N. Creek		2,926	
8/19	Kakhonak River		855	
8/19	Alec Flyum Creek		360	
	Bear Creek		No survey	
8/19	Cabin Creek		190	
8/19	Granite Creek		390	
8/19	Lake Creek		830	
		TOTAL	5,551	1.32
	SW Streams			
	Camp Creek		No survey	
	Dennis Creek		No survey	
8/03	Belinda Creek		6,915	
		TOTAL	6,915	1.64

Table 6. Peak indices of abundance of sockeye salmon to 14 geographic regions of the Kvichak River system in 1982 (continued).

Survey Date	Area	1982 index	Percent of total accounted for in 1982 stream surveys
	Island Beaches (Iliamna Lake)		
8/19	Rabbit Island Group	275	
8/19	Eagle Island Group	125	
8/06	Triangle Island Group and Reefs	90	
8/06	Halfway Island and Reefs	0	
8/06	Seal Rookery Island	0	
8/06	E-2 Island Group	0	
8/06	Knutson Island Group	1,700	
	Hedlund Island Group	No survey	
	Knutson Islets	No survey	
8/06	Woody Island-Flat Island Group	6,595	
8/19	Pedro Island Group	420	
8/06	Porcupine Island Group	1,955	
8/06	Ross Island Group and Reefs	165	
	Kakhonak Bay Island Group	No survey	
	Middle Islands	No survey	
	Intricate Bay Island Group	No survey	
	TOTAL	11,325	2.69
	N. Shore Beaches		
8/03	Eagle Bay	No survey*	
8/03	Chekok	No survey*	
8/19	Knutson Bay	14,700	
	Pedro Peninsula	No survey	
	Pedro Bay	No survey	
	Lincoln Rock	No survey	
8/19	Lonesome Bay	1,925	
	Dumbell Lakes	No survey	
	Chekok Lakes	No survey	
	TOTAL	16,625	3.95
	S. Shore Beaches		
8/19	Pile Bay	10	
8/19	Finger	6,350	
8/19	Southeast	790	
8/19	Southshore	245	
8/19	Tommy	3,335	
	Intricate Bay	No survey	
	Kakhonak Bay	No survey	
	TOTAL	10,730	2.55
Total spawning ground index		420,790	
Kvichak River 1982 escapement		1,134,840	
37.08 percent of total escapement accounted for in stream surveys			

*Area surveyed but fish observed probably spawned elsewhere.

Table 7. Comparison of 1982 stream survey indices of spawners to fourteen geographic regions of the Kvichak River system to geometric mean escapement indices and mean percentage to same geographic regions in non-peak cycle years, 1955-1974.

Area	1982		Non-Peak Years 1955-1974	
	Escapement Index	Percent of Total Accounted for from Stream Surveys	Geometric Mean Escapement Index	Mean Percentage
NW Streams	33,483	7.96	16,125	8.59
Newhalen R. System	97,297	23.12	5,340	2.85
Lake Clark	21,060	5.00	10,119	5.39
NE Streams	23,568	5.60	8,726	4.65
NE Ponds	356	.09	2,992	1.59
Iliamina R. System	35,780	8.50	26,630	14.19
SE Streams & Ponds	2,610	.62	2,441	1.30
Intricate Bay Streams	63,810	15.16	39,881	21.25
Gibraltar System	91,680	21.80	29,064	15.49
Kakhonak Bay Streams	5,551	1.32	1,475	.79
SW Streams	6,915	1.64	1,761	.94
Island Beaches	11,325	2.69	22,363	11.92
N. Shore Beaches	16,625	3.95	13,790	7.35
S. Shore Beaches	10,730	2.55	6,952	3.70
TOTALS	420,790	100.00	187,659	100.00

Table 8. Stream survey indexes of sockeye salmon in the Newhalen River from 1982 aerial surveys.

Area	Date of survey				
	July 10	August 3	August 6	August 19	September 16
Outside mouth	500	14,685	*	13,075	*
Mouth to RM 2	4,500	2,410	*	5,875	690
RM 2 to RM 6.5	100	15,975	3,975	2,100	125
RM 6.5 to Portage	200	14,375	25,075	28,425	2,160
Portage to RM 22 or Six-Mile Lake	200	14,920	23,750	14,625	2,085
Quality of survey	Good	Very good	Good	Mostly good	Mostly poor
Total	5,500	67,365	52,800	64,100	5,060

* Area not covered in survey.

Table 9. Comparison of the percentage of the 1982 Kvichak River escapement that returned to the Newhalen River-Lake Clark system from results of the stream survey and the Newhalen River enumeration program.

Area	Index	Percent of total accounted for on spawning grounds	Tower count[1] plus index	Percent of[2] Kvichak River escapement
Newhalen R. system	97,297	23.12	147,294 (tower)	12.98
Lake Clark	21,060	5.00	66,555 (index)	5.86
TOTALS	118,357	28.13	213,849	18.84

1/ Spawner index for areas below Newhalen RM 22 counting station. It should be cautioned that we are combining an index of escapement (areas below counting station) with an estimate of true escapement obtained from a systematic count over time with no adjustment being made to expand index to represent the true number of spawners in the Newhalen River system below the counting station.

2/ Neither the Kvichak River nor the Newhalen River escapement estimates are adjusted for catches of subsistence fisheries.

Table 10. Mean size[1] (mm) of sockeye salmon by sex and age group, and sex ratio in samples from the Nondalton subsistence fishery, Newhalen River-Lake Clark escapement, 1982.

				AGE CLASS																				
				4_2 (1.2)			4_3 (2.1)			5_2 (1.3)			5_3 (2.2)			6_3 (2.3)			6_4 (3.2)			7_4 (3.3)		
Date	Sex	N	Sex ratio (Percent) (F:Cx100)	n	Size (mm)	%	n	Size (mm)	%	n	Size (mm)	%	n	Size (mm)	%	n	Size (mm)	%	n	Size (mm)	%	n	Size (mm)	%
July 14	M	41	(F:Cx100)	29	541.8	70.7	1	435.0	2.4	4	591.3	9.8	1	451.0	2.4	6	604.0	14.6				0	0	0
	F	60	59.4%	48	525.0	80.0	0	0	0	4	583.3	6.7	4	512.5	6.7	3	582.7	5.0				1	586.0	1.7
	C	101		77	531.3	76.3	1	435.0	1.0	8	587.3	7.9	5	500.2	5.0	9	596.9	8.9				1	586.0	.9
July 18	M	11		7	562.7	63.6				3	611.3	27.3	1	590.0	9.0	0	0	0						
	F	20	64.5	10	537.8	50.0				5	572.6	25.0	2	530.0	10.0	3	582.7	15.0						
	C	31		17	548.1	54.8				8	587.1	25.8	3	550.0	9.7	3	582.7	9.7						
July 20	M	77		55	545.8	71.4				10	604.7	13.0	2	569.0	2.6	10	611.7	13.0				0	0	0
	F	94	55.0	63	524.9	67.0				13	577.8	13.8	3	521.7	3.2	14	583.1	15.0				1	568.0	1.0
	C	171		118	534.6	69.0				23	589.5	13.5	5	540.6	2.9	24	595.0	14.0				1	568.0	.6
July 23	M	71		55	543.0	77.5				6	609.3	8.5	3	579.7	4.2	7	603.9	9.9						
	F	79	52.7	52	516.5	65.8				10	585.8	12.7	3	503.7	3.8	14	578.9	17.7						
	C	150		107	530.1	71.4				16	594.6	10.6	6	541.5	4.0	21	587.2	14.0						
July 28	M	22		16	544.8	72.7				2	608.5	9.0	3	588.0	13.6	1	539.0	4.5						
	F	15	40.5	6	531.3	40.0				1	592.0	6.6	3	564.6	20.0	5	581.8	33.3						
	C	37		22	541.1	59.5				3	603.0	8.1	6	576.3	16.2	6	574.7	16.2						
August 3	M	94		59	540.7	62.8				18	605.2	19.1	12	582.8	12.8	5	628.4	5.3	0	0	0			
	F	92	49.5	55	530.4	59.8				10	599.2	10.9	15	548.9	16.3	11	590.0	12.0	1	520.0	1.1			
	C	186		114	535.7	61.4				28	603.1	15.0	27	564.0	14.5	16	602.0	8.6	1	520.0	.5			
August 6	M	20		13	535.8	65.0				3	616.3	15.0	0	0	0	4	619.8	20.0						
	F	20	50.0	13	522.6	65.0				3	598.0	15.0	3	550.0	15.0	1	601.0	5.0						
	D	40		26	529.2	65.0				6	607.2	15.0	3	550.0	7.0	5	616.0	13.0						
August 9	M	62		44	536.7	71.0	2	434.0	3.2	8	584.4	18.2	3	591.3	6.8	5	579.6	11.4						
	F	43	41.7	27	526.2	62.8	0	0	0	5	580.8	11.6	5	532.6	11.6	6	586.3	14.0						
	C	105		71	532.7	67.6	2	434.3	1.9	13	583.0	12.4	8	554.6	7.6	11	583.3	10.5						
Combined	M	398		278	542.2	69.8	3	434.3	.7	54	602.5	13.6	25	578.9	6.3	38	606.0	9.5	0	0	0	0	0	0
	F	423	51.5	274	525.0	64.8	0	0	0	51	585.3	12.1	38	537.5	9.0	57	583.9	13.5	1	520.0	.2	2	577.0	.5
	C	821		552	533.7	67.2	3	434.3	.4	105	594.1	12.8	63	553.9	7.7	95	592.7	11.6	1	520.0	.1	2	577.0	.2

1/ Measurements are mid-eye to fork of tail (ME-TF).

Table 11. Number, mean size (mm) of sockeye salmon by sex and age group, and sex ratio for individual sampling periods and all sampling periods combined, Kvichak escapement, 1982.

Period		AGE CLASS 3_1 (0.2)	3_2 (1.1)	4_2 (1.2)	4_3 (2.1)	5_2 (1.3)	5_3 (2.2)	6_2 (1.4)	6_3 (2.3)	Total	Sex ratio % F : C x 100
Period 1 July 4-10	Males (M)										
	Number		9,972	158,554	1,994	62,824	12,964	0	23,933	270,241	
	Av. length		337.4	525.4	422.5	582.6	543.2	0	590.4	537.6	
	%		3.69	58.67	.74	23.25	4.80	0	8.86	100.0	
	Sample size		10	159	2	63	13	0	24	271	
	Females (F)										
	Number		997	220,381	0	67,810	27,922	997	9,972	328,079	
	Av. length		430.0	505.7	0	562.5	525.2	588.0	580.6	521.4	
	%		.30	67.17	0	20.67	8.51	.30	3.04	100.0	
	Sample size		1	221	0	68	28	1	10	329	
	Sexes combined (C)										
	Number		10,969	378,935	1,994	130,634	40,886	997	33,905	598,320	
	Av. length		345.8	513.9	422.5	572.2	530.9	588.0	587.5	528.7	
	%		1.83	63.33	.33	21.83	6.83	.16	5.66	100.0	54.8
	Sample size		11	380	2	131	41	1	34	600	
Period 2 July 11-16	Males (M)										
	Number		14,714	45,171	4,106	22,243	5,817	342	10,950	103,343	
	Av. length		339.2	513.1	370.6	585.9	527.4	615.0	594.5	508.1	
	%		14.23	43.71	3.97	21.52	5.63	.33	10.60	100.0	
	Sample size		43	132	12	65	17	1	32	302	
	Females (F)										
	Number		342	75,283	1,369	18,478	8,897	0	3,764	108,133	
	Av. length		410.0	502.8	401.0	555.6	511.2	0	574.6	513.4	
	%		.32	69.62	1.27	17.09	8.23	0	3.48	100.0	
	Sample size		1	220	4	54	26	0	11	316	
	Sexes combined (C)										
	Number		15,056	120,454	5,475	40,721	14,714	342	14,714	211,476	
	Av. length		340.8	506.7	378.2	572.2	517.6	615.0	589.4	510.8	
	%		7.12	56.96	2.59	19.26	6.96	.16	6.96	100.0	51.1
	Sample size		44	352	16	119	43	1	43	618	
Period 3 July 17-20	Males (M)										
	Number	1,215	30,378	52,250	8,506	47,390	9,113	0	15,189	164,041	
	Av. length	397.5	338.3	521.5	376.4	581.7	540.3	0	593.8	504.3	
	%	.74	18.52	31.85	5.19	28.89	5.56	0	9.26	100.0	
	Sample size	2	50	86	14	78	15	0	25	270	
	Females (F)										
	Number	0	608	106,322	0	30,986	13,974	0	9,113	161,003	
	Av. length	0	390.0	506.6	0	564.5	524.7	0	573.3	522.7	
	%	0	.38	66.04	0	19.25	8.68	0	5.66	100.0	
	Sample size	0	1	175	0	51	23	0	40	265	
	Sexes combined (C)										
	Number	1,215	30,986	158,572	8,506	78,376	23,087	0	24,302	325,044	
	Av. length	397.5	339.3	511.5	376.4	574.9	530.9	0	586.1	513.4	
	%	.37	9.53	48.78	2.62	24.11	7.10	0	7.48	100.0	49.5
	Sample size	2	51	261	28	129	38	0	40	535	
All periods	Males (M)										
	Number	1,215	55,064	255,975	14,606	132,457	27,894	342	50,072	537,625	
	Av. length	397.5	338.4	522.4	381.1	582.8	539.0	615.0	592.3	521.8	
	%	.23	10.24	47.61	2.72	24.64	5.19	.06	9.31	100.0	
	Sample size	2	103	377	28	206	45	1	81	910	
	Females (F)										
	Number	0	1,947	401,986	1,369	117,274	50,793	997	22,849	597,215	
	Av. length	0	414.0	505.4	401.0	561.9	522.6	588.0	576.7	520.3	
	%	0	.33	67.31	.23	19.64	8.50	.17	3.83	100.0	
	Sample size	0	3	616	4	173	77	1	36	910	
	Sexes combined (C)										
	Number	1,215	57,011	657,961	15,975	249,731	78,687	1,339	72,921	1,134,840	
	Av. length	397.5	341.0	512.0	382.8	573.0	528.4	594.9	587.4	521.0	
	%	.11	5.02	57.98	1.41	22.01	6.93	.12	6.43	100.0	52.6
	Sample size	2	106	993	32	379	122	2	117	1,753	

Table 12. Number, mean size (mm) of sockeye salmon by sex and age group, and sex ratio for individual sampling periods combined, Newhalen RM 22 escapement, 1982.

Period		AGE CLASS 4_2 (1.2)	4_3 (2.1)	5_2 (1.3)	5_3 (2.2)	6_3 (2.3)	6_4 (3.2)	7_4 (3.3)	Total	Sex ratio % F : C x 100
Period 1 July 9-18	Males (M)									
	Number	7,188	200	1,398	399	1,198	0	0	10,383	
	Av. length	545.9	435.0	599.9	520.5	604.0	0	0	556.8	
	%	69.23	1.92	13.46	3.85	11.54	0	0	100.0	
	Sample size	36	1	7	2	6	0	0	52	
	Females (F)									
	Number	11,582	0	1,797	1,198	1,198	0	200	15,975	
	Av. length	527.2	0.0	577.4	518.3	582.7	0	586.0	537.1	
	%	72.50	0.0	11.25	7.50	7.50	0	1.25	100.0	
	Sample size	58	0	9	6	6	0	1	80	
	Sexes combined (C)									
	Number	18,770	200	3,195	1,597	2,396	0	200	26,358	
	Av. length	534.4	435.0	587.2	518.9	593.4	0	586.0	544.9	
	%	71.21	.76	12.12	6.06	9.09	0	.76	100.0	60.6
	Sample size	94	1	16	8	12	0	1	132	
Period 2 July 19-28	Males (M)									
	Number	11,137	0	1,591	707	1,591	0	0	15,026	
	Av. length	544.5	0	606.7	580.1	604.6	0	0	559.1	
	%	74.1	0	10.59	4.71	10.59	0	0	100.0	
	Sample size	126	0	18	8	18	0	0	170	
	Females (F)									
	Number	10,696	0	2,121	796	2,917	0	88	16,618	
	Av. length	521.6	0	581.7	530.0	581.1	0	568.0	540.4	
	%	64.36	0	12.77	4.79	17.55	0	.53	100.0	
	Sample size	121	0	24	9	33	0	1	188	
	Sexes combined (C)									
	Number	21,833	0	3,712	1,503	4,508	0	88	31,644	
	Av. length	533.2	0	592.4	553.6	589.4	0	568.0	549.3	
	%	68.99	0	11.73	4.75	14.25	0	.28	100.0	52.5
	Sample size	247	0	42	17	51	0	1	358	
Period 3 July 29 - end of run	Males (M)									
	Number	31,293	540	7,823	4,046	3,777	0	0	47,479	
	Av. length	538.6	434.0	600.6	584.5	608.5	0	0	557.1	
	%	65.9	1.14	16.48	8.52	7.95	0	0	100.0	
	Sample size	116	2	29	15	14			176	
	Females (F)									
	Number	25,627	0	4,856	6,204	4,856	270	0	41,813	
	Av. length	528.1	0	593.9	545.5	589.4	520.0	0	545.4	
	%	61.29	0	11.61	14.84	11.61	.65	0	100.0	
	Sample size	95	0	18	23	18	1	0	155	
	Sexes combined (C)									
	Number	56,920	540	12,679	10,251	8,632	270	0	89,292	
	Av. length	533.9	434.0	598.0	560.9	597.8	520.0	0	551.6	
	%	63.75	.60	14.20	11.48	9.67	.30	0	100.0	46.8
	Sample size	211	2	47	38	32	1	0	331	
Combined total	Males (M)									
	Number	49,618	740	10,812	5,152	6,566	0	0	72,888	
	Av. length	541.0	434.3	601.4	578.9	606.7	0	0	557.5	
	%	68.07	1.02	14.83	7.07	9.01	0	0	100.0	
	Sample size	278	3	54	25	38	0	0	398	
	Female (F)									
	Number	47,905	0	8,774	8,198	8,971	270	288	74,406	
	Av. length	526.4	0	587.6	540.0	585.8	520.0	580.5	542.5	
	%	64.38	0	11.79	11.02	12.06	.36	.39	100.0	
	Sample size	274	0	51	38	57	1		423	
	Sexes combined (C)									
	Number	97,523	740	19,586	13,350	15,537	270	288	147,294	
	Av. length	533.8	434.3	595.2	555.0	594.6	520.0	580.5	549.5	
	%	66.21	.50	13.30	9.06	10.55	.18	.20	100.0	50.5
	Sample size	552	3	105	63	95	1	2	821	

Table 13. Percentage age composition[1] of sockeye salmon in samples from spawning grounds and the Kvichak River, Igiugig escapement, 1982.

Location	Sex	N	Age Class 3_1 (0.2)	3_2 (1.1)	4_2 (1.2)	4_3 (2.1)	5_2 (1.3)	5_3 (2.2)	6_2 (1.4)	6_3 (2.3)	6_4 (3.2)	7_4 (3.3)
Iliamna Lake[1]												
Woody Island	M	115	0	3.5	42.6	0	34.8	17.4	0	1.7	0	0
	F	124	0	0	46.0	0	43.5	8.9	0	1.6	0	0
	C	239	0	1.7	44.3	0	39.3	13.0	0	1.7	0	0
Copper River	M	104	0	1.0	48.0	0	20.2	22.1	0	8.7	0	0
	F	120	0	0	53.4	0	23.3	17.5	0	5.8	0	0
	C	224	0	.4	51.0	0	21.9	19.6	0	7.1	0	0
Gibraltar Creek	M	119	0	0	37.0	0	53.0	5.0	0	5.0	0	0
	F	115	0	0	53.1	0	34.8	7.8	0	4.3	0	0
	C	234	0	0	44.9	0	44.0	6.4	0	4.7	0	0
Combined total	M	338	0	1.5	42.3	0	36.7	14.5	0	5.0	0	0
	F	359	0	0	50.7	0	34.0	11.4	0	3.9	0	0
	C	697	0	.7	46.7	0	35.3	12.9	0	4.4	0	0
Newhalen River-Lake Clark[1]												
Nondalton Fishery	M	398	0	0	69.8	.7	13.6	6.3	0	9.5	0	0
	F	423	0	0	64.8	0	12.1	9.0	0	13.5	.2	.5
	C	821	0	0	67.2	.4	12.8	7.7	0	11.6	.1	.2
Tazimina River	M	99	0	1.0	80.9	4.0	3.0	10.1	0	1.0	0	0
	F	99	0	0	92.0	0	1.0	5.0	0	2.0	0	0
	C	198	0	.5	86.4	2.0	2.0	7.6	0	1.5	0	0
Newhalen River (RM 16)	M	101	0	9.9	83.1	2.0	4.0	1.0	0	0	0	0
	F	107	0	0	96.3	0	2.8	0	0	.9	0	0
	C	208	0	4.8	89.8	1.0	3.4	.5	0	.5	0	0
Combined total	M	598	0	1.8	74.1	1.5	10.0	6.0	0	6.5	0	0
	F	629	0	0	74.4	0	8.8	6.8	0	9.6	.3	.2
	C	1,227	0	.9	74.2	.7	9.4	6.5	0	8.1	.2	.1
Iliamna Lake	M	936	0	1.7	62.5	1.0	19.7	9.1	0	6.0	0	0
Newhalen R.-Lake Clark	F	988	0	0	65.7	0	17.9	8.5	0	7.5	.2	.1
Combined	C	1,924	0	.8	64.2	.5	18.8	8.8	0	6.8	.1	.05
ADF&G sampling[2]	M	843	.2	12.2	44.7	3.3	24.4	5.3	.1	9.6	0	0
Kvichak River	F	910	0	.3	67.7	.4	19.0	8.5	.1	4.0	0	0
Escapement (Igiugig)	C	1,753	.1	6.0	56.7	1.8	21.6	7.0	.1	6.7	0	0

[1]FRI aging by otoliths.

[2]ADF&G aging by scales. Data Source: Preliminary summary Kvichak escapement of sockeye salmon by age, length and wegith, 1982. Provided by Henry Yuen, ADF&G Commercial Fish Division, Anchorage, January 1983.

Table 14. Percentage age composition of sockeye salmon by brood year in samples from Kvichak spawning grounds and Igiugig, Kvichak River escapement, 1982.

Location	1979 brood year (3-year-old fish) Age 3_1 (0.2)		3_2 (1.1)	1978 brood year (4-year-old fish) Age 4_3 (2.1)		4_2 (1.2)	1977 brood year (5-year-old-fish) Age 5_3 (2.2)		5_2 (1.3)	1976 brood year (6-year-old-fish) Age 6_3 (2.3)		6_4 (3.2)	Sample size (No. aged)
Iliamna Lake													
Woody Island	0		1.7	0		44.3	13.0		39.3	1.7		0	
Total		1.7			44.3			52.3			1.7		239
Cooper River	0		.4	0		51.0	19.0		21.9	7.1		0	
Total		.4			51.1			41.5			7.1		224
Gibraltar Creek	0		0	0		44.9	6.4		44.0	4.7		0	
Total		0			44.9			50.4			4.7		234
Combined total		.7			46.7			48.2			4.4		697
Newhalen River-Lake Clark													
Nondalton fishery	0		0	.4		67.2	7.7		12.8	11.6		.2	
Total		0			67.6			20.5			11.8		821
Tazimina River	0		.5	2.0		86.4	7.6		2.0	1.5		0	
Total		.5			88.4			9.6			1.5		198
Newhalen River (RM 16)	0		4.8	1.0		89.8	.5		3.4	.5		0	
Total		4.8			90.8			3.9			.5		208
Combined total	0		.9	.7		74.2	6.5		9.4	8.1		.2	
		.9			74.9			15.9			8.3		1,227
Iliamna Lake Newhalen R.-Lake Clark Combined	0		.8	.5		64.2	8.8		18.8	6.8		.1	
		.8			64.7			27.6			6.9		1,924
ADF&G sampling Kvichak escapement	.1		5.0	1.4		58.0	6.9		22.0	6.4		.1*	
		5.1			59.4			28.9			6.5		1,134,840[1/]

[1/] Represents apportioned Kvichak River escapement by age (total sample size or number of fish aged = 1,753).

*Represents age class 6_2 (1.4).

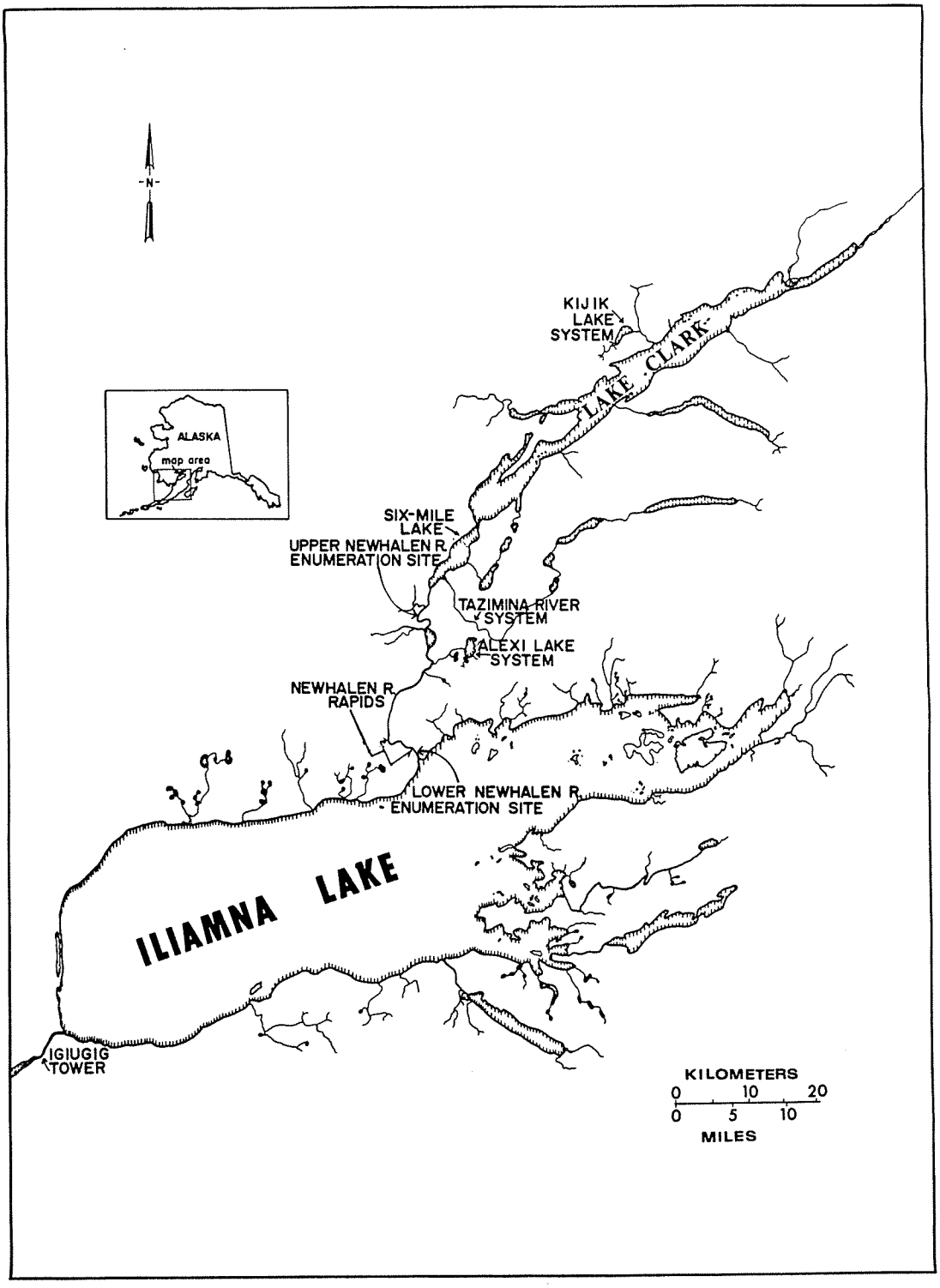

Fig. 1. Kvichak River system showing the location of the ADF&G Igiugig tower, the FRI Newhalen River counting stations at RM 1 and RM 22, and the major spawning units of the Newhalen River-Lake Clark system.

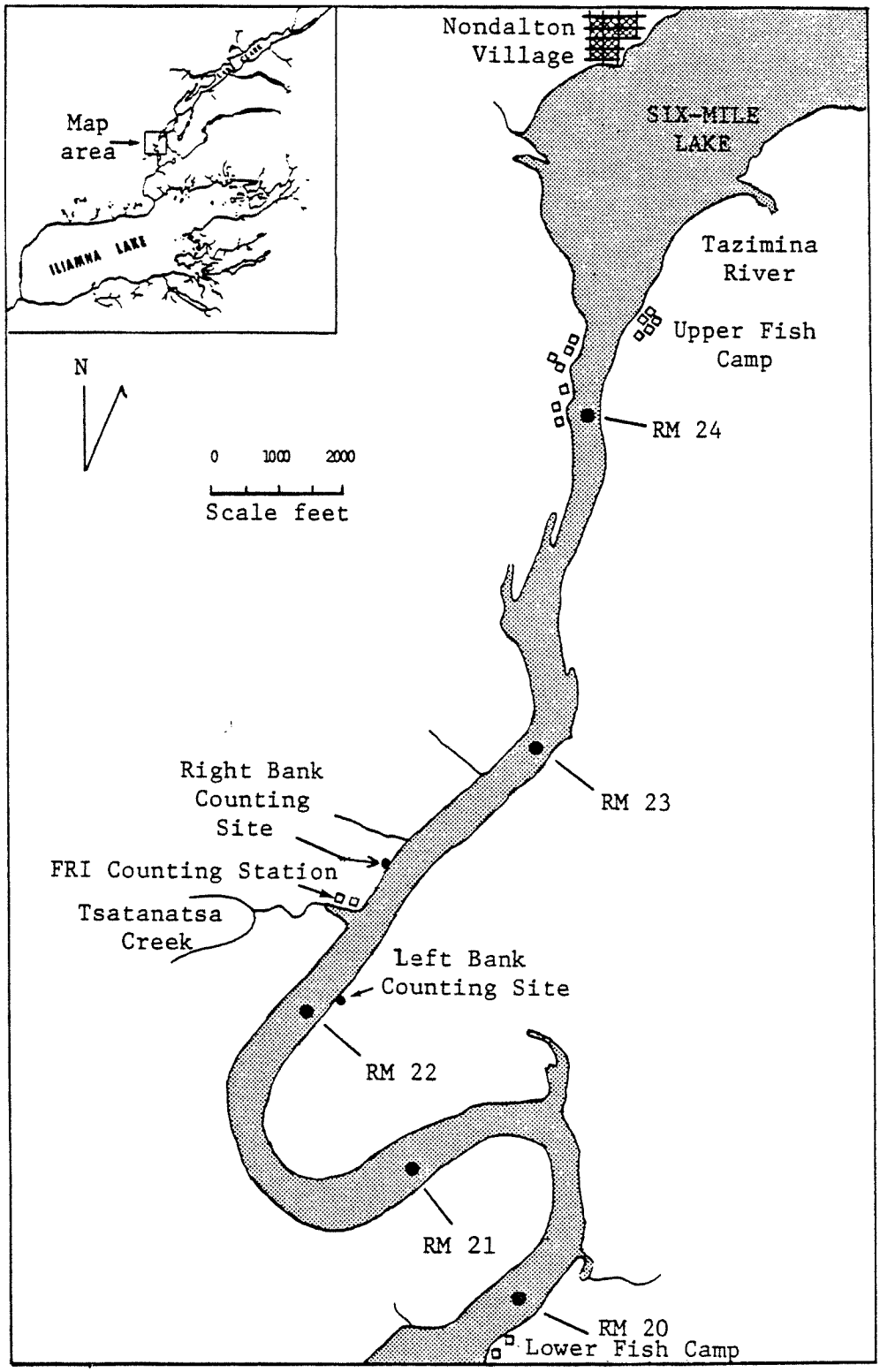

Fig. 2. Location of RM 22 counting station and 1982 counting sites.

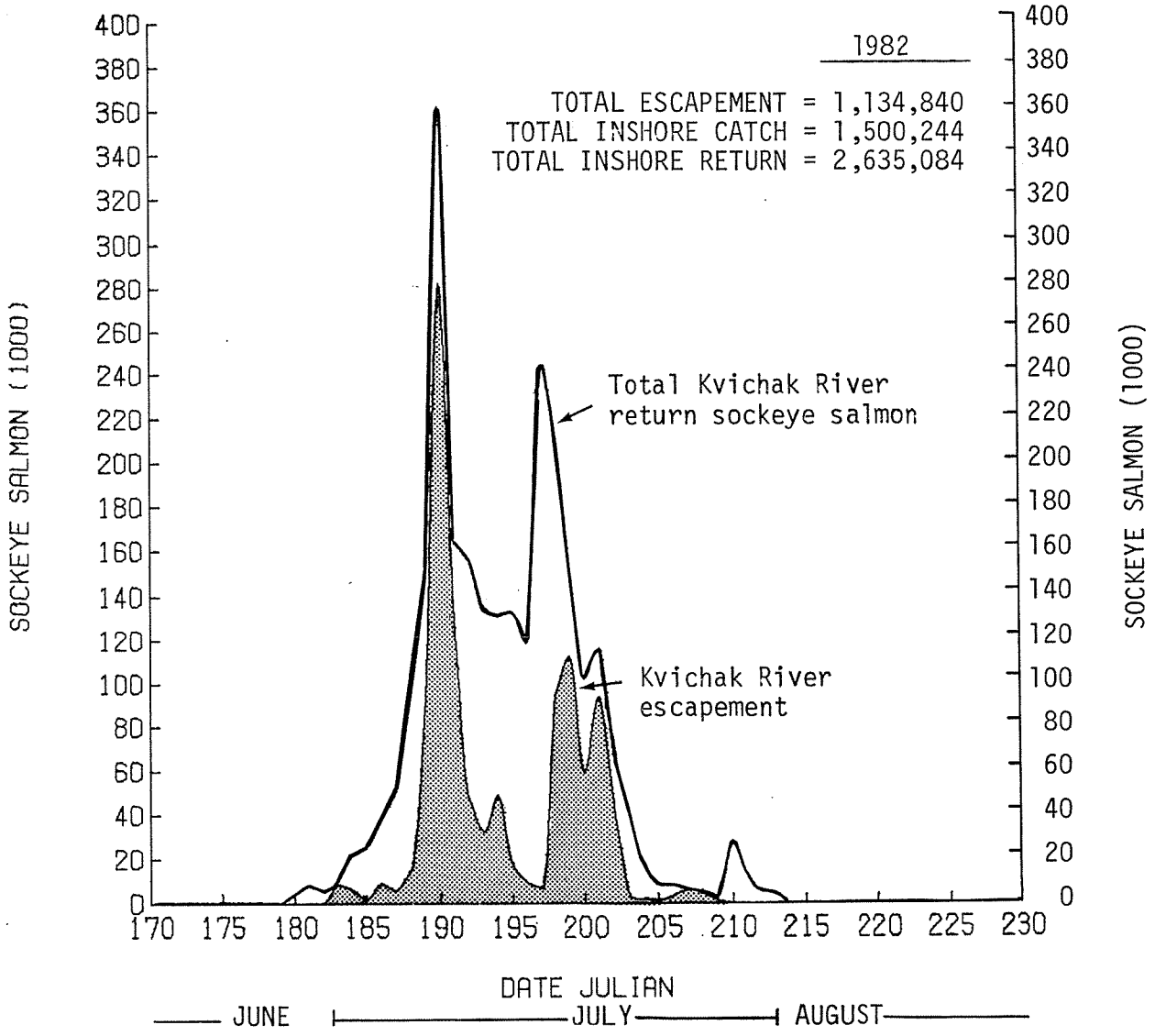

Fig. 3. Daily Kvichak River sockeye salmon runs referenced to the head of the Kvichak River. Shaded areas are daily escapements.

Data Source: 1982 Naknek-Kvichak District preliminary catch data (pers. comm. Henry Yuen, ADF&G 12/09/82).

Procedure used in calculating daily Kvichak runs: Daily Naknek-Kvichak District catches multiplied by .3008 (portion Kvichak catch represented of total Naknek-Kvichak District catch), lagged seven days and added to daily Igiugig escapements.

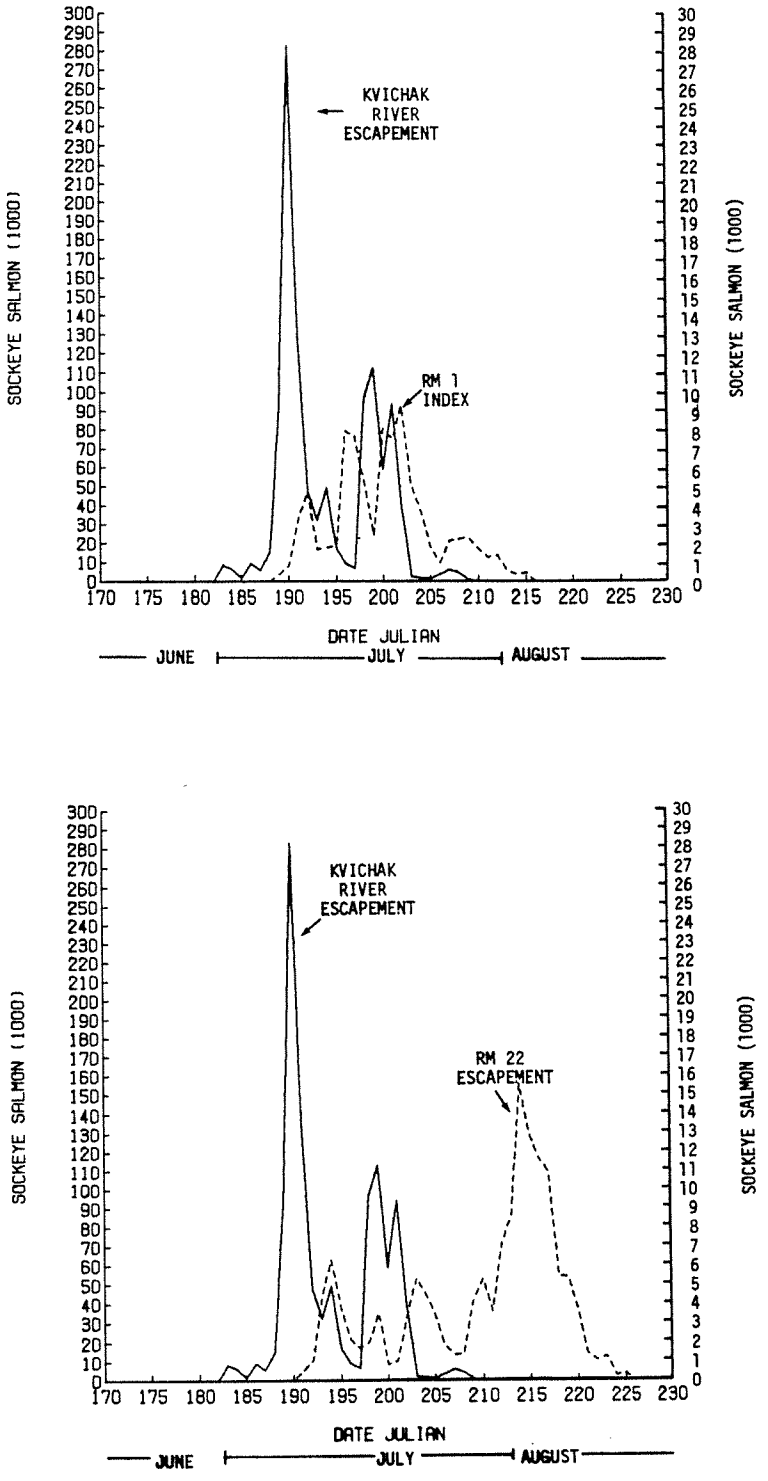

Fig. 4. Daily escapements of sockeye salmon to the Kvichak River system (solid) compared to daily 10-hour index of escapement at RM 1 (upper graph-dash) and daily escapements to spawning areas above Newhalen RM 22 (lower graph-dash).

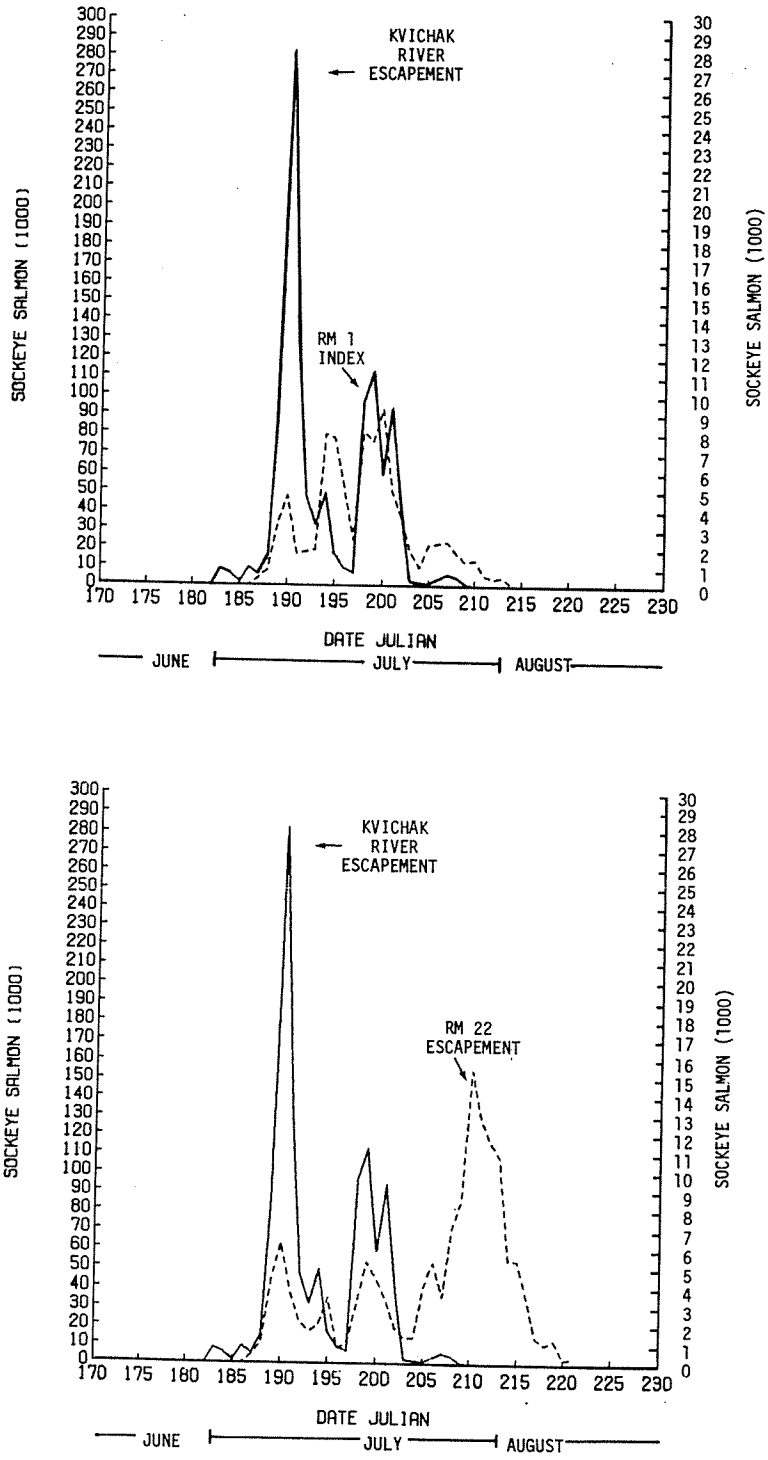

Fig. 5. Daily escapements of sockeye salmon to the Kvichak River system (solid) compared to 10-hour index of escapement at RM 1 back-lagged 2 days (upper graph dash) and daily escapements to spawning areas above Newhalen RM 22 back-lagged 4 days (lower graph-dash).

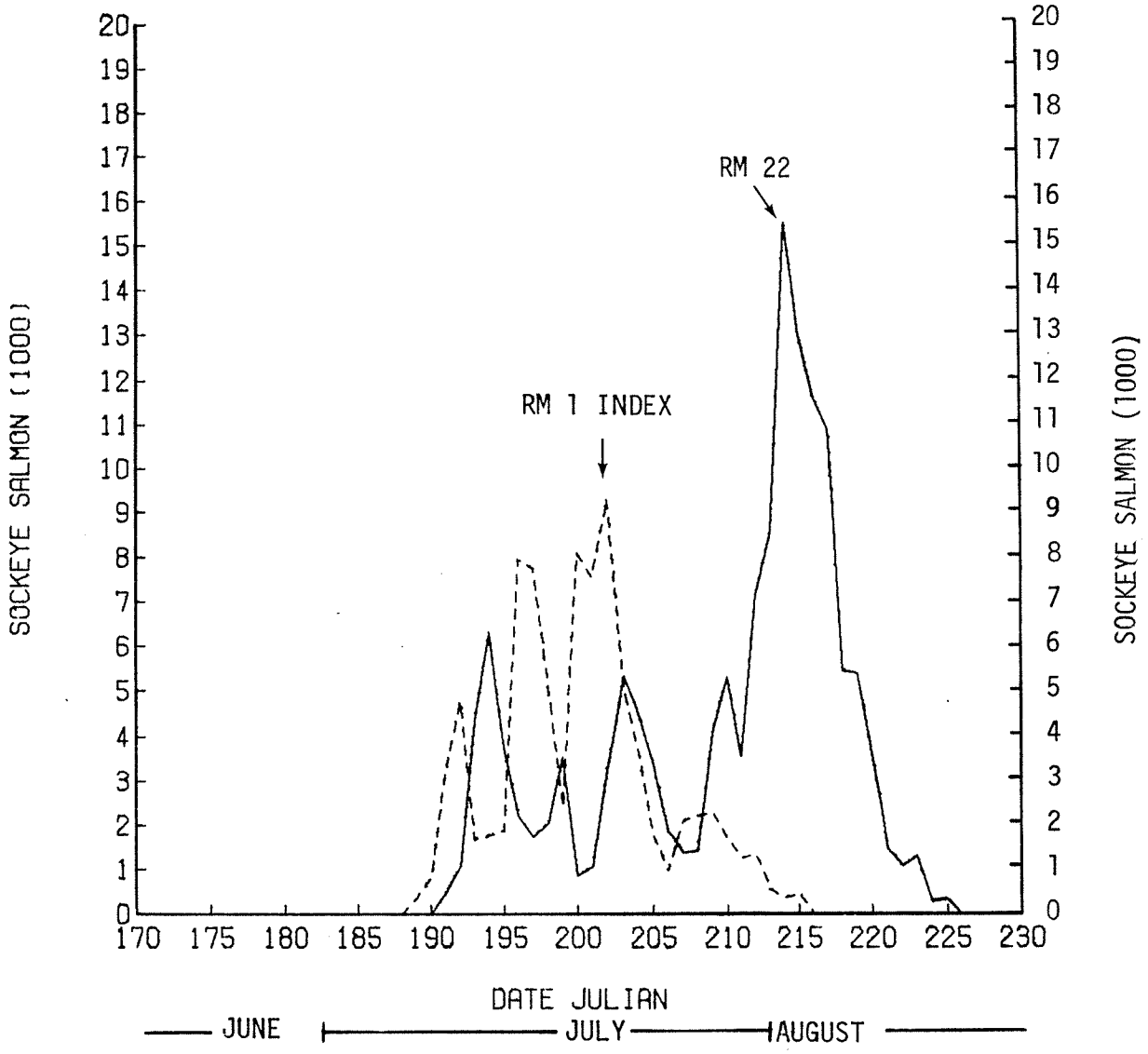

Fig. 6. Newhalen River daily escapement index at RM 1 and daily escapement at RM 22.

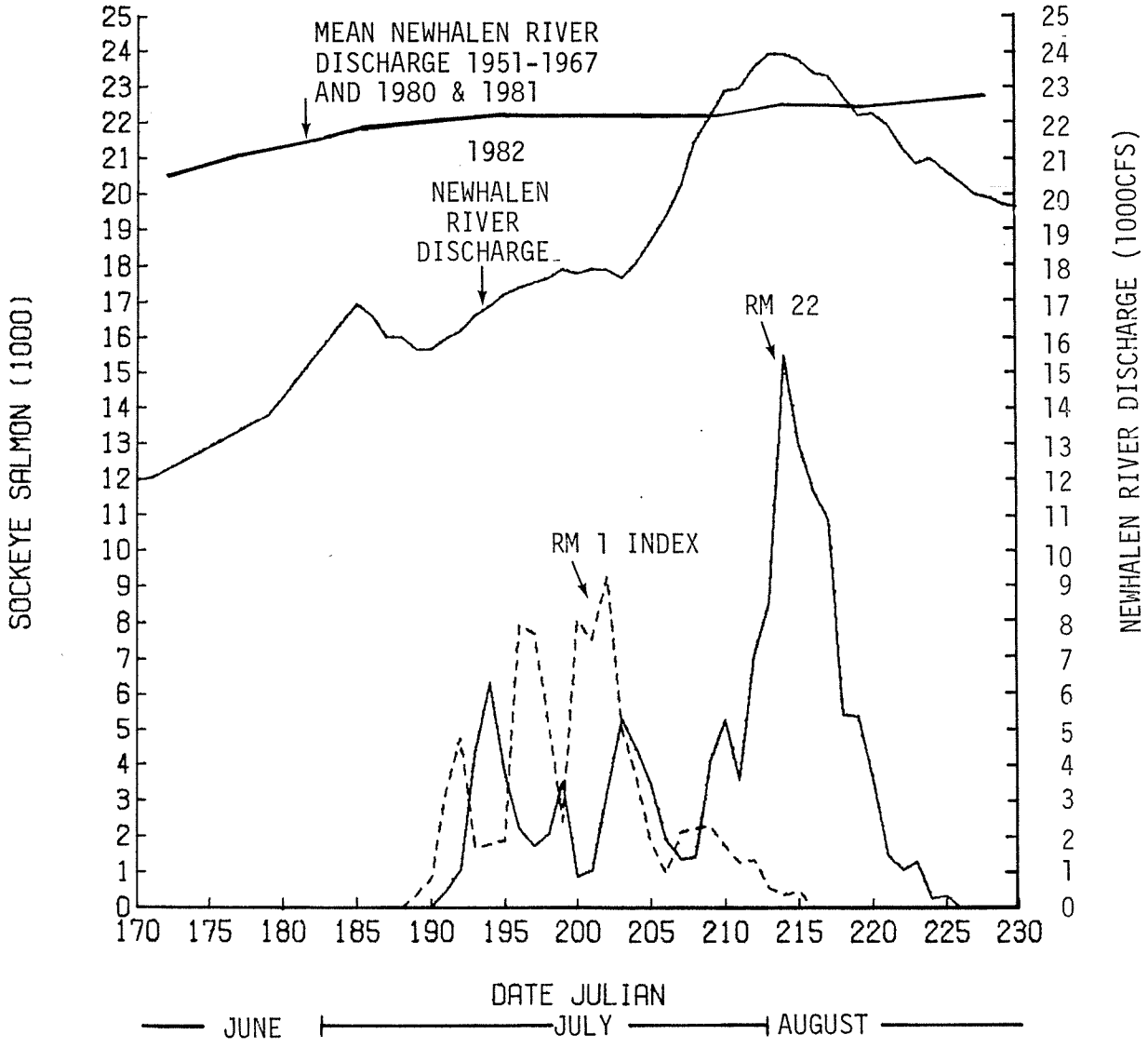

Fig. 7. Daily escapement patterns at Rm 1 (dash) and RM 22 (solid), estimated 1982 Newhalen River discharge, and mean Newhalen River discharge, 1951-1967 and 1980 & 1981.

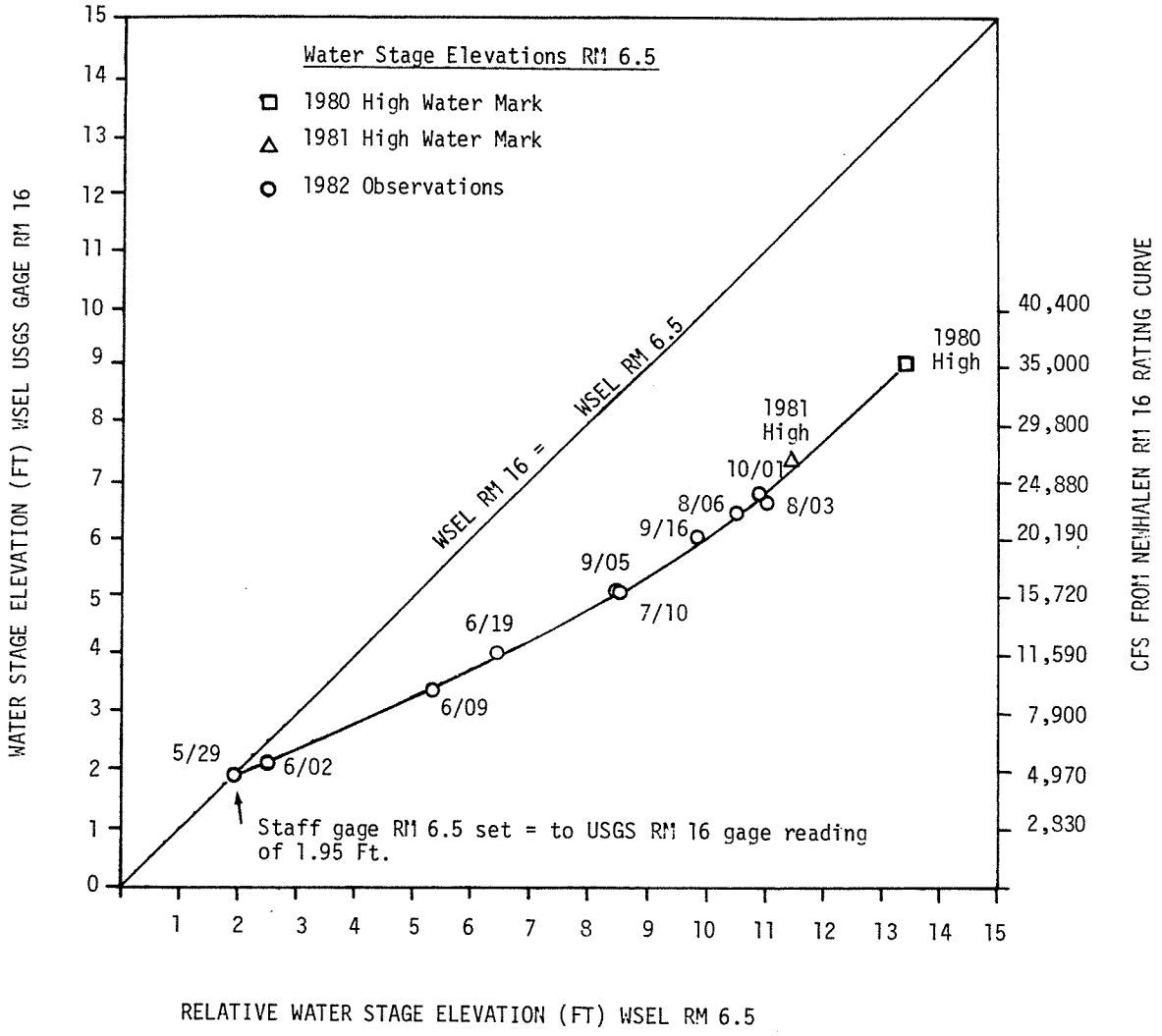

Fig. 8. Relationship of changes in river stage elevation at RM 6.5 to RM 16 USGS gage.

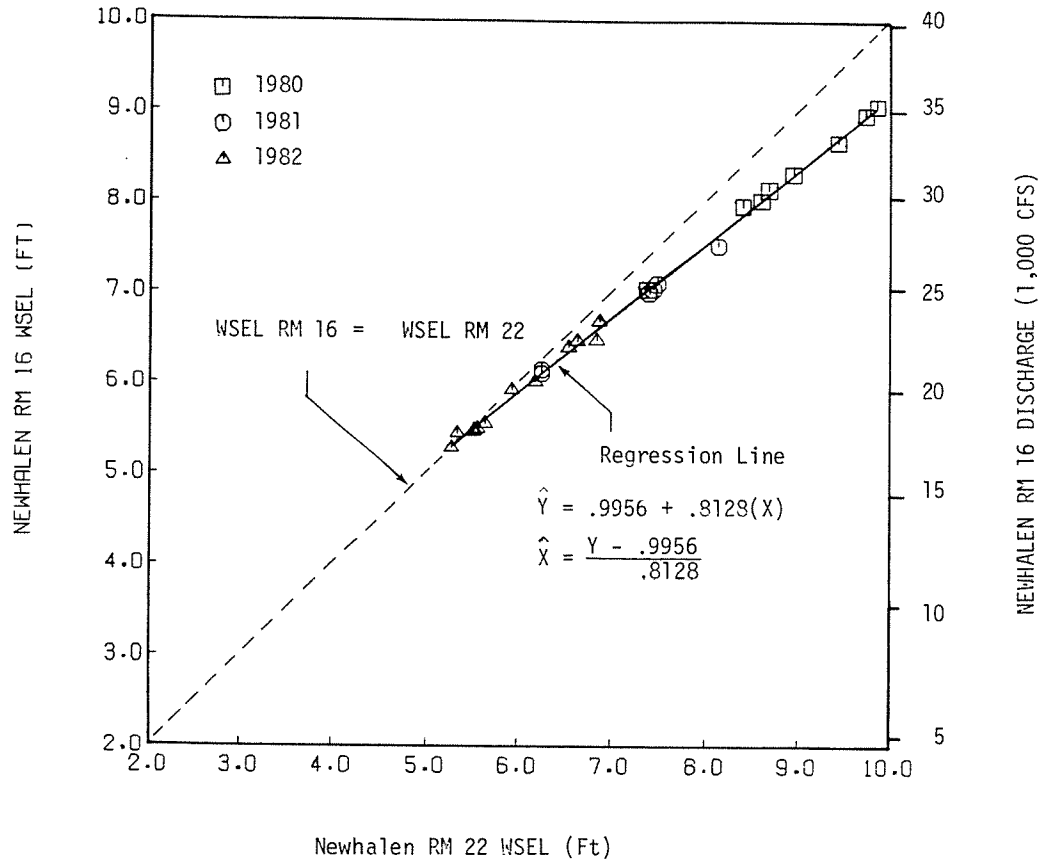

Fig. 9. Relationship Newhalen RM 16 river stage elevation to RM 22 water stage elevation (WSEL), 1980-1982.

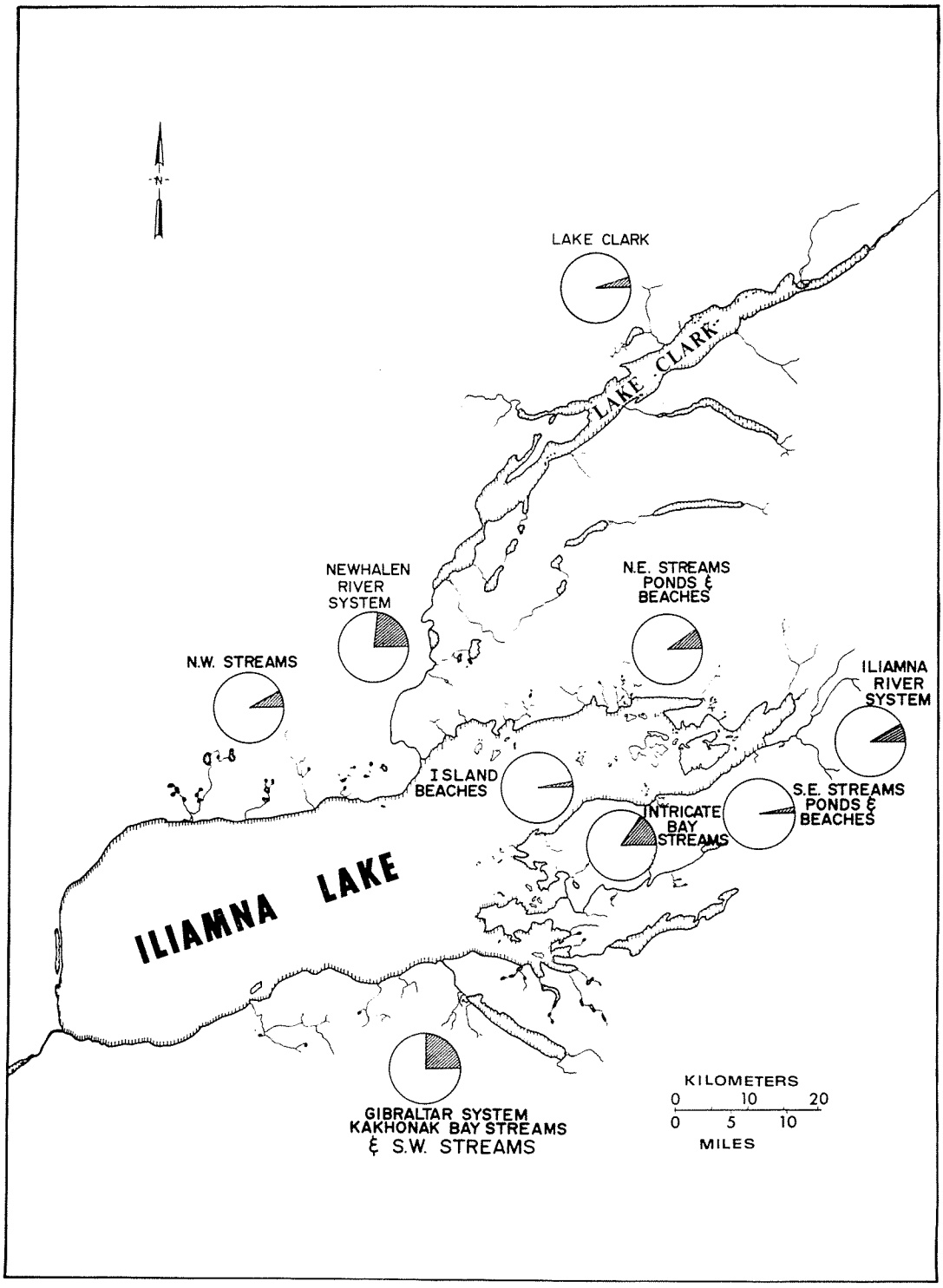

Fig. 10. Distribution of spawners on Kvichak spawning grounds, 1982.

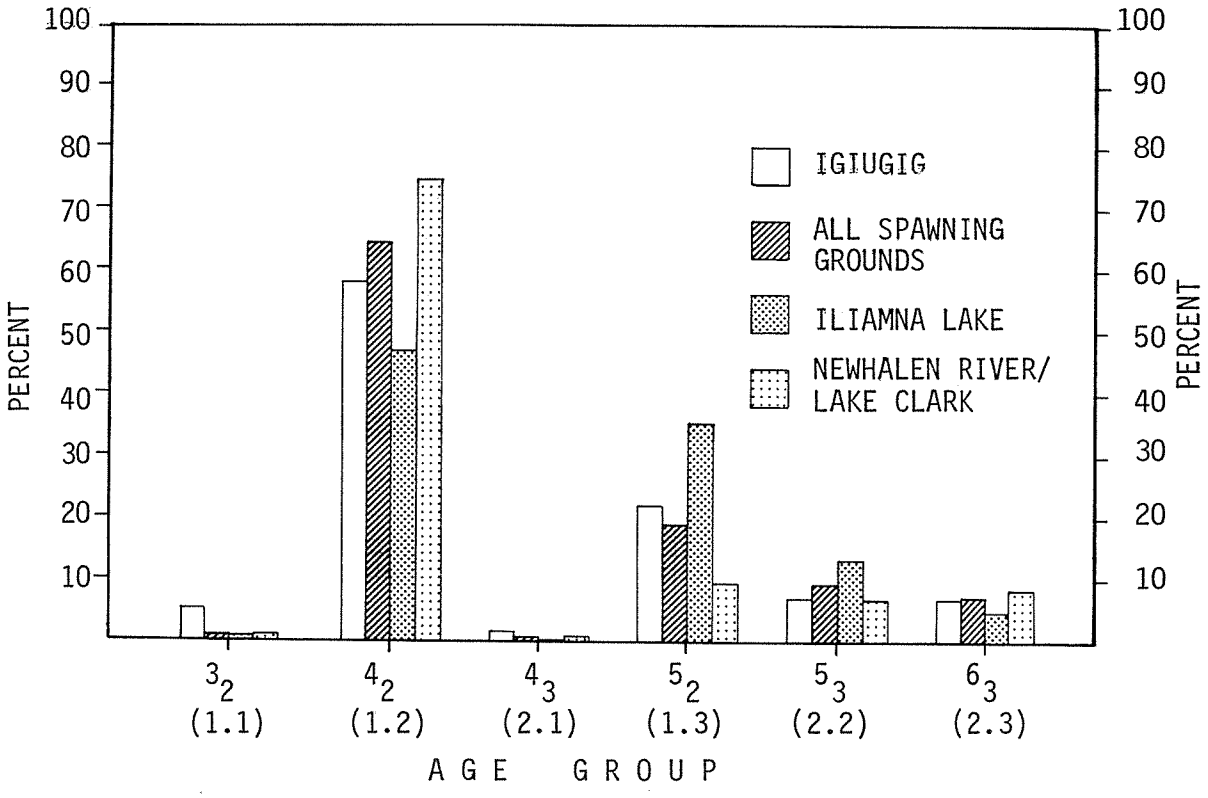

Fig. 11. Percentage age composition of sockeye salmon by major age groups in Kvichak River escapement (Igiugig), Iliamna Lake- Newhalen River/ Lake Clark samples combined, Iliamna Lake, and Newhalen River/Lake Clark , 1982.

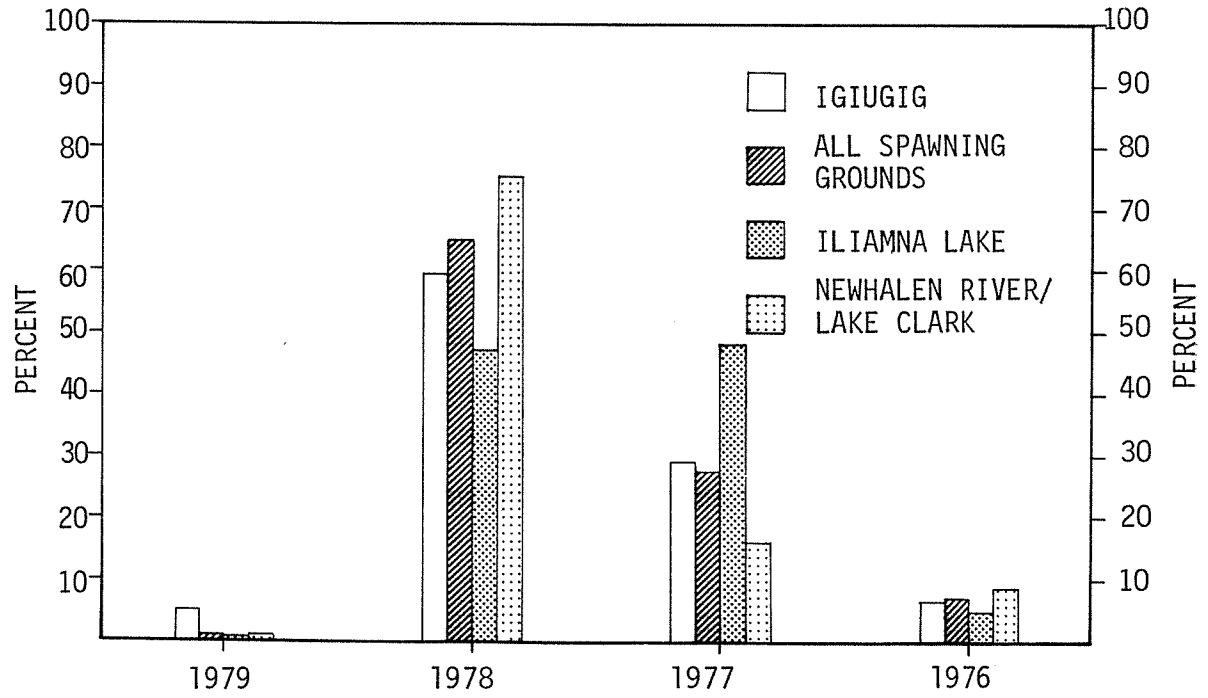

Fig. 12. Percentage age composition of sockeye salmon by brood year in Kvichak River escapement (Igiugig), Iliamna Lake-Newhalen River/ Lake Clark samples combined, Iliamna Lake, and Newhalen River/ Lake Clark, 1982.

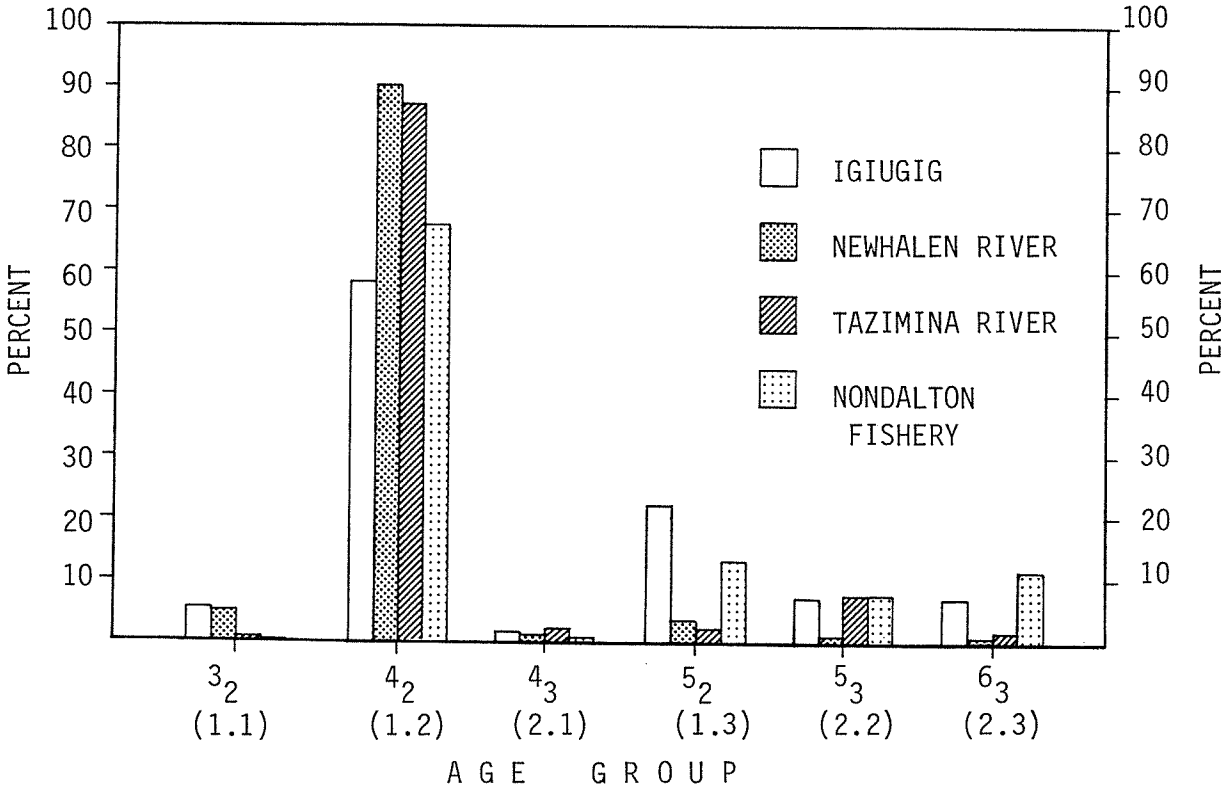

Fig. 13. Percentage age composition of sockeye salmon in Kvichak River escapement (Igiugig), Newhalen River, Tazimina River and Nondalton Fishery, 1982.

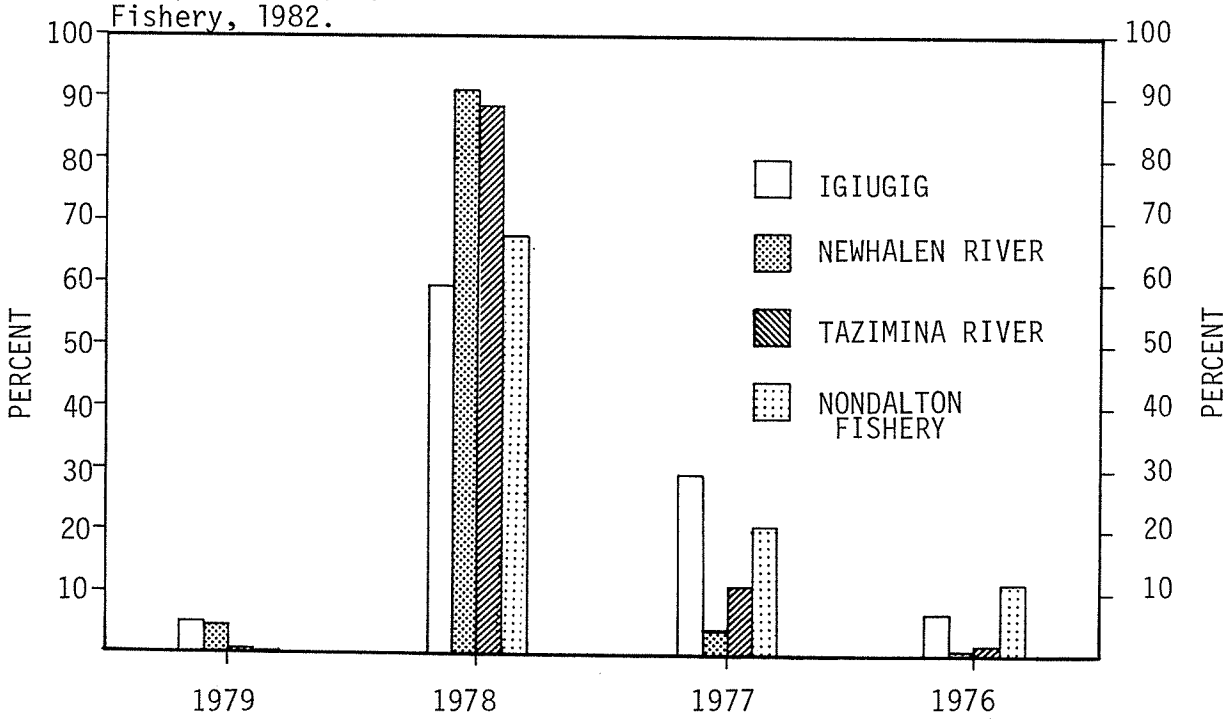

Fig. 14. Percentage age composition of sockeye salmon by brood year in Kvichak River escapement (Igiugig), Newhalen River, Tazimina River and Nondalton Fishery, 1982.

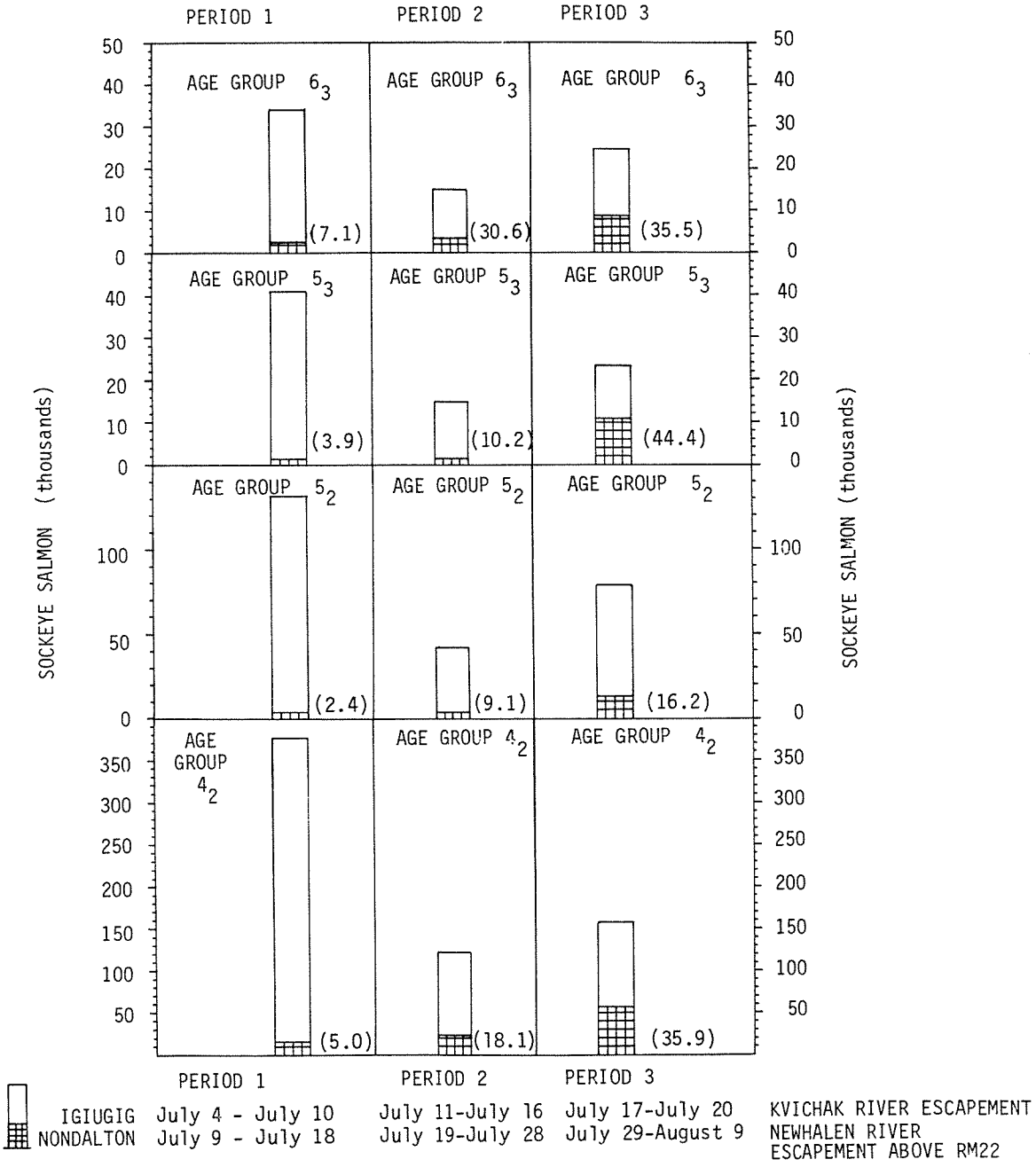

Fig. 15. Abundance of 4-major age groups in 1982 Kvichak (Igiugig) and Newhalen River (RM 22) escapements by sampling period. The percentage of the Kvichak escapement that the Newhalen escapement represents in parenthesis.

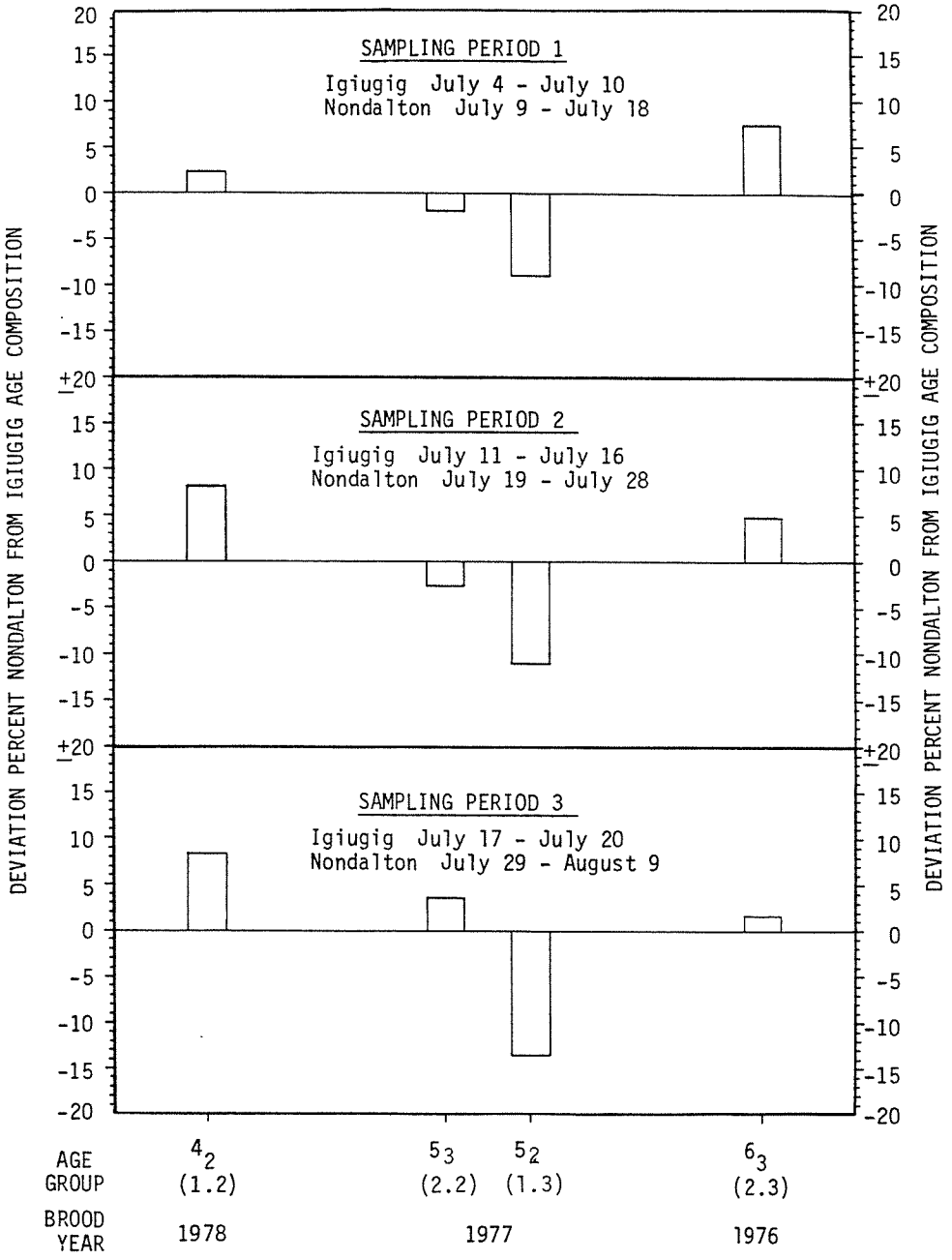

Fig. 16. Deviation (%) of Nondalton from Kvichak escapement age composition, sexes combined, four major age groups by sampling period, 1982.

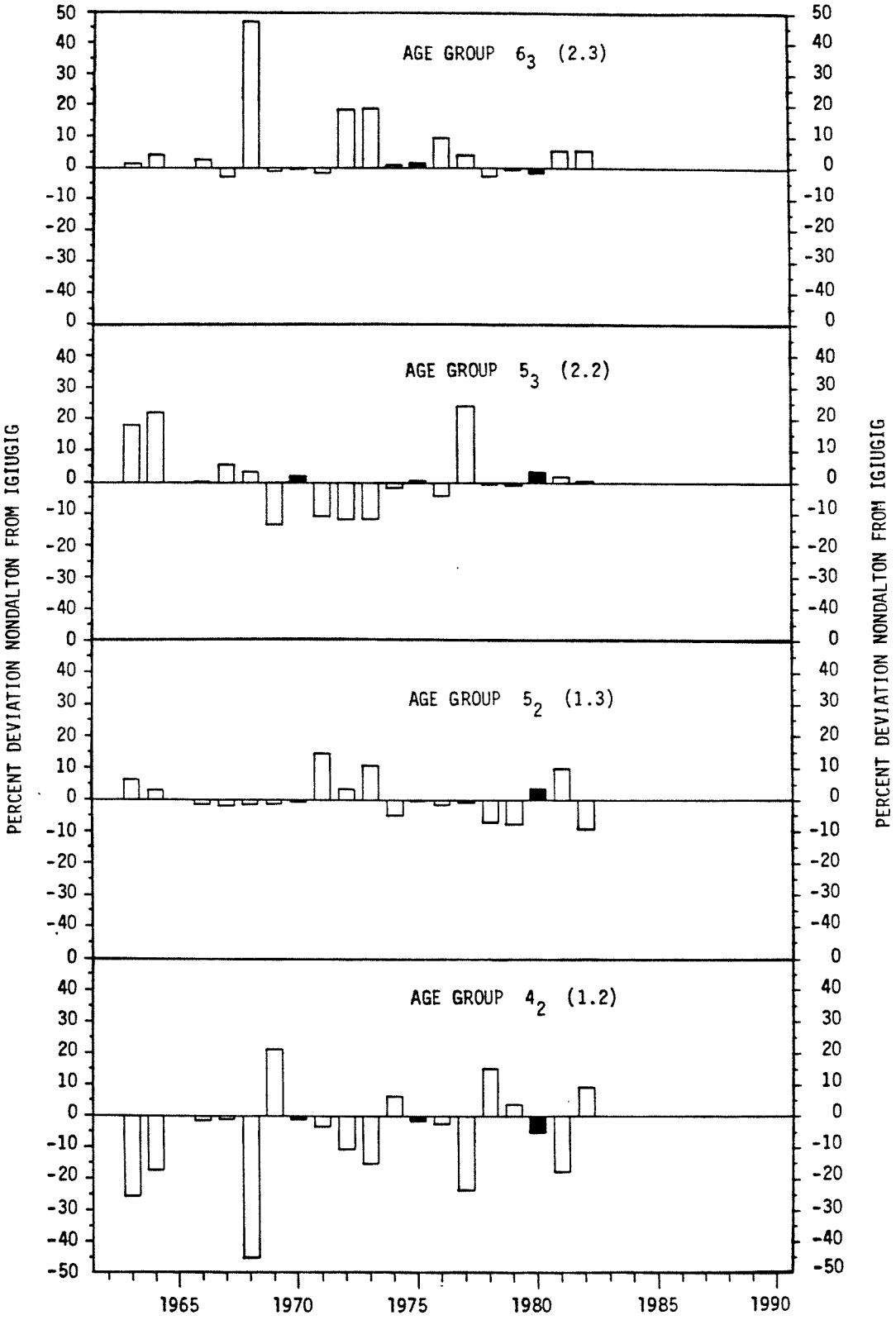

Fig. 17. Deviation (%) of Nondalton from Kvichak escapement (Igiugig sampling) age composition, sexes combined, 4-major age groups, 1962-1982.

7.0 APPENDICES

7.1 Appendix A

Newhalen River Level and
Discharge Information
from FRI and Dames & Moore
Studies at RM 22

1980-1982

Appendix A.1 Standardized water stage elevation and discharge information from FRI and Dames & Moore studies conducted at RM 22, 1980-1982. Numbers in parentheses represent hindcast values of water stage elevation derived from later observations and real-time log notes; numbers in square brackets represent linear estimates between days of observation.

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	6.04	20,420	5.28	5.28*	16,942
4	186	(7.20)	(6.89)	24,352	6.16	6.00	20,190	5.20	5.22	16,678
5	187				6.03	5.90	19,730	5.03	5.08	16,064
6	188				6.07	5.93	19,868	5.03	5.08	16,064
7	189				6.05	5.91	19,776	4.93	5.00	15,720
8	190				6.04	5.90	19,730	4.93	5.00	15,720
9	191				6.14	5.99	20,144	5.02	5.08	16,064
10	192	(8.00)	(7.50)	27,300	6.27	6.09	20,604	5.08	5.12	16,238
11	193				6.37	6.17	20,972	5.20	5.22	16,590
12	194				6.55	6.32	21,664	5.28	5.27*	16,898
13	195				6.67	6.42	22,134	5.37	5.36	17,294
14	196				6.76	6.49	22,463	5.41	5.39	17,426
15	197	(8.55)	(7.95)	29,550	6.89	6.60	22,980	5.45	5.43	17,605
16	198				7.01	6.69	23,403	5.48	5.45	17,695
17	199				7.10	6.77	23,779	5.54	5.50	17,920
18	200				7.25	6.89	24,352	5.57	5.48*	17,830
19	201				7.35	6.97	24,736	5.55	5.51	17,965
20	202				7.41	6.98*	24,784	5.54	5.50	17,920
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	5.67	18,685
24	206				7.54	7.08*	25,264	5.93	5.82	19,362
25	207				7.62	7.14*	25,552	6.19	6.00*	20,190
26	208				7.64	7.21	25,888	6.48	6.26	21,386
27	209				7.67	7.23	25,984	6.66	6.41	22,087
28	210				7.62	7.19	25,792	6.83	6.55	22,745
29	211	9.28	8.54*	32,568	7.57	7.15	25,600	6.87	6.58	22,886
30	212	9.23	8.50	32,360	7.58	7.16	25,648	7.01	6.69	23,403
31	213	9.23	8.50	32,360	7.49	7.08*	25,264	7.11	6.77	23,779
Aug 1	214	9.19	8.47	32,204	7.51	7.10	25,360	7.11	6.77	23,779
2	215	9.17	8.45	32,100	7.67	7.23	25,984	7.08	6.75	23,685
3	216	9.14	8.42	31,944	7.92	7.43	26,950	6.98	6.67	23,309
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	6.53	22,651
6	219	8.84	8.18	30,700	7.97	7.47	27,150	6.68	6.43	22,181
7	220	8.79	8.14	30,500	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	8.03	29,950				6.44	6.23	21,248
10	223	8.66	8.03	29,950				6.33	6.14	20,834
11	224	8.84	8.18	30,700				6.36	6.17	20,972
12	225	9.18	8.45	32,100		7.49*	27,250	6.27	6.09	20,604
13	226	9.45	8.64*	33,088				6.20	6.03	20,328
14	227	9.47	8.69	33,348				6.10	5.95	19,960
15	228	9.42	8.65	33,140	8.15**	7.50*	27,300	6.08	5.94	19,914

Appendix A.1, cont'd

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 16	229	9.38	8.62	32,984				6.03	5.90	19,730
17	230	9.35	8.60	32,880		7.40*	26,800	6.01	5.88	19,638
18	231	9.35	8.60	32,880				5.94	5.91*	19,730
19	232	9.68	8.86	34,244		7.25*	26,080	5.86	5.76	19,135
20	233	9.87	9.02	35,108				5.76	5.68	18,730
21	234	9.88	9.04*	35,216				5.66	5.60	18,370
22	235	9.75	8.94*	34,676	7.15	6.81	23,968	5.58	5.53	18,055
23	236	9.55	8.76	33,712				5.51	5.47	17,785
24	237	9.36	8.60	32,880		7.08*	25,264	5.45	5.43	17,605
25	238	9.12	8.41	31,892				5.40	5.38	17,382
26	239	8.89	8.22	30,904	6.47	6.25	21,340	5.35	5.43*	17,605
27	240	8.62	8.00*	29,800				5.26	5.27	16,898
28	241	8.42	7.94*	29,500		6.32*	21,664	5.18	5.21	16,634
29	242	8.17	7.64	28,000		6.29*	21,524	5.14	5.17	16,458
30	243	7.93	7.44	27,000				5.18	5.21	16,634
31	244	7.78	7.32	26,416				5.18	5.21	16,634
Sep 1	245	7.57	7.15	25,600				5.16	5.19	16,546
2	246	7.39	7.02*	24,976				5.09	5.12	16,238
3	247	7.20	6.85	24,160				5.04	5.09	16,107
4	248	6.96	6.65	23,215				4.95	5.02	15,806
5	249	6.74	6.47	22,369	6.26	6.13*	20,788	5.15	5.18	16,502
6	250	6.51	6.29	21,524				5.26	5.27	16,898
7	251	6.51	6.29	21,524				5.47	5.44	17,650
8	252	[6.22]	6.05	20,420				5.54	5.47*	17,785
9	253	[5.93]	5.82	19,362	5.88	5.77	19,135	5.60	5.55	18,145
10	254	5.64	5.58	18,280				5.64	5.58	18,280
Sep 11	255	5.47	5.44	17,650				5.60	5.55	18,145
12	256	5.37	5.36	17,294				5.65	5.59	18,325
13	257	5.34	5.34	17,206				5.64	5.58	18,280
14	258	5.31	5.31	17,074				5.60	5.55	18,145
15	259	5.36	5.35	17,250				5.80	5.71	18,865
16	260	5.54	5.50	17,920				6.30	6.12	20,742
17	261	5.62	5.56	18,190				6.85	6.46*	22,322
18	262	5.74	5.66	18,640				7.11	6.77	23,779
19	263	5.72	5.64	18,550				7.30	6.93	24,544
20	264	5.70	5.63	18,505				7.42	7.03	25,024
21	265	5.69	5.62	18,460				7.40	7.01	24,928
22	266	5.62	5.57	18,235				7.54	7.12	25,456
23	267	5.51	5.48	17,830				7.52	7.11	25,408
24	268	5.34	5.34	17,206				7.45	7.05	25,120
25	269							7.35	6.97	24,736
26	270							7.18	6.83	24,064
27	271							7.13	6.79	23,873
28	272							7.08	6.75	23,685

[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 campsite. Benchmark = blazed small (4-inch diameter) spruce tree. Datum of 9.23 ft at RM 22 is equivalent to 8.50 ft water stage elevation at U.S.G.S. RM 16 gaging station.

[2]Estimated water stage elevation at U.S.G.S. RM 16 gaging station from relationship of RM 22 to RM 16 gage readings, 1980-1982 (see Appendix A.2).

[3]Discharge calculated from U.S.G.S. rating curve for RM 16.

*Direct readings of water stage elevation made by either FRI or Dames and Moore personnel at U.S.G.S. RM 16 gaging station. Readings in 1980 and 1981 are from stilling well, and readings in 1982 are from either recorder or stilling well (see Appendix A.2 and Appendix B).

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

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

1980			1981			1982		
	Water stage elevation			Water stage elevation			Water stage elevation	
Date	RM 22	RM 16	Date	RM 22[2/]	RM 16	Date	RM 22[2/]	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*
	n=8			n=8		8/18	5.94	5.91*
						8/26	5.35	5.43*
						9/08	5.54	5.47**
						9/17	6.85	6.46**
							n=12	

Regression equation:
$Y = .9956 + .8128(X)$ $(R^2 = .9975)$
Where: X = RM 22 water stage elevations in feet
Y = Estimate " " " " "
at RM 16.

1/ Data points where RM 16 water stage elevation below 6 feet in 1980 and 1981 not included as Dames and Moore personnel determined that river was not communicating accurately with stilling well below approximately 6 feet. USGS personnel corrected this situation in 1982.

2/ Water stage elevations at RM 22 standardized to 1980 datum.

3/ Values in brackets [ ] represent maximum water stage elevations from high water marks on staff gages.

* Represents gage readings in stilling well.

** Represents readings from recorder.

7.2 Appendix B

Observations of Newhalen River
water stage elevation made at
RM 16 USGS gage by FRI and
Dames & Moore personnel

1982

Appendix B. Observations of Newhalen River water stage elevation made at RM 16 USGS gage by FRI and Dames & Moore personnel in 1982.

Date		Water stage elevation (feet) Newhalen RM 16 USGS gage: Recorder reading	Stilling well reading	Remarks
May	10	1.20		USGS personnel installed recorder.
	21	1.60		
	29	1.95		Staff gauge installed at RM 6.5 0 = 1.95 ft.
June	2	2.19		
	7	3.22		
	19	4.11		Dames & Moore water air temperature data pad moved from RM 7 to RM 16.
	27		4.54	
July	3		5.28	FRI adult counting station established at RM 22.3.
	12	5.27		
	18	5.48		
	21	5.45		
	22	5.54		
	25		6.00	
	30	[6.18][1/]		Recorder not working. Notified USGS, Anchorage.
August	4	[6.18]	6.67	
	7	[6.39]	6.45	Installed one new battery.
	8	[6.35]	6.38	Installed second new battery.
	18	[6.26]	5.91	Recorder still not functioning
	26	[6.26]	5.43	correctly.
September	8	5.47	5.50	Recorder functioning.
	17	6.46	6.46	Heavy rain, river rising again.
October	1	6.75		

[1/] Assume recorder stopped functioning correctly approximately July 25 when heavy rains drenched equipment in gage house. Values in brackets [ ] represent readings during the period the recording unit was malfunctioning.