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# Bristol Bay Sockeye Salmon Smolt Studies for 1989

by

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and

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## ABSTRACT

Numbers of sockeye salmon *Oncorhynchus nerka* smolt migrating to sea from five rivers in Bristol Bay, Alaska, in 1989 were estimated from sonar counts and age-weight-length samples. Hydroacoustic equipment was used to estimate total smolt biomass, while age-weight-length samples were used to convert biomass estimates to numbers of smolt by age group. Estimated numbers of smolt migrating from each river were 153,464,216 from Kvichak River; 99,886,786 from Egegik River; 126,298,122 from Ugashik River; 41,299,040 from Wood River; 6,154,491 from Nuyakuk River. Age-I smolt (the progeny of 1987 spawners) predominated from each river: Kvichak (95.5%), Egegik (72.5%), Ugashik (74.0%), Wood (91.3%), and Nuyakuk, (90.8%).

KEY WORDS: smolt, sockeye salmon, *Oncorhynchus nerka*, smolt migration, sonar, Bristol Bay, Kvichak River, Egegik River, Ugashik River, Wood River, Nuyakuk River

## INTRODUCTION

The Bristol Bay Management Area includes all waters east of a line from Cape Newenham to Cape Menshikof (Figure 1) and supports the largest sockeye salmon *Oncorhynchus nerka* fishery in the world. The annual Bristol Bay commercial catch from 1980 through 1989 has averaged 22.5 million sockeye salmon. To effectively manage this valuable fishery, managers need accurate abundance forecasts for returning adults and information on optimal spawning escapement numbers. Estimates of smolt numbers are used as an index of production from adult salmon, which in turn should provide better descriptions of return-per-spawner relationships, improve the accuracy of preseason forecasts, and aid in setting goals for optimal numbers of spawners.

Fyke nets were used to estimate smolt numbers on the Kvichak River from 1956 through 1970; on the Naknek River from 1956 through 1978; on the Egegik River during 1957, 1969, and 1978; on the Ugashik River from 1955 through 1965, 1967 through 1970; and 1972 through 1975, and on the Wood River from 1951 through 1966 (see Kerns 1961; Rietze and Spangler 1958; Jaenicke 1968; Pella and Jaenicke 1978; Burgner and Koo 1954; Burgner 1962). Fyke net sampling provided information on age, size, and relative abundance of smolt but did not accurately estimate total numbers. To improve estimates of smolt numbers, hydroacoustic equipment developed by Bendix Corporation[1] was tested on the Kvichak River in 1969 (McCurdy and Paulus 1972; Paulus and Parker 1974). Further testing and modification of this prototype resulted in construction of smolt counters for use on the Wood (Krasnowski 1976) and Kvichak Rivers (Randall 1977) in 1975 and 1976.

Hydroacoustic equipment for counting smolt was tested on the Ugashik River from 1973 through 1975 (Schroeder 1974b and 1975; Sanders 1976). Smolt studies on the Naknek, Egegik, Ugashik, and Nuyakuk Rivers were limited to occasional fyke net sampling to obtain age and size data from 1975 through 1982 (Huttunen 1980; Eggers 1984; Minard 1984). An experimental, two-array hydroacoustic system, similar to the one used on the Kvichak River, was tested on the Egegik River during 1981 (Bue 1982).

Smolt enumeration projects using modified counters were started on the Naknek and Egegik Rivers in 1982 (Huttunen 1984; Bue 1984) and the Ugashik and Nuyakuk Rivers in 1983 (Fried et al. 1987; Minard and Frederickson 1987). The migration of smolt from the Naknek River has not been monitored since 1986.

The relationship between growth rate and survival of young sockeye salmon in the Bristol Bay area is not well understood. Burgner (1962) found the plerocercoid stage of the cestode *Triaenophorus crassus* to be a common parasite of smolt from Wood River. The effect of this cestode on rearing sockeye salmon is unknown, but Burgner (1962) suggested that parasitism might be a factor contributing to slow growth rate, which might result in greater fresh-water mortality. Smolt from Wood River have been examined for the presence or absence of *T. crassus* since 1948. The presence or absence of *T. crassus* was noted for each Wood River smolt examined in 1989 for age, weight, and length data.

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[1] Mention of a product name does not constitute an endorsement by the Department of Fish and Game.

Studies were conducted on the Kvichak, Egegik, Ugashik, Wood, and Nuyakuk Rivers in 1989 to (1) estimate numbers of seaward migrating sockeye salmon smolt, (2) describe smolt migration patterns, (3) collect age, weight, and length data for smolt, and (4) record climatological and hydrological parameters which may affect migratory behavior.

## METHODS

### *Hydroacoustic Equipment*

Bendix Corporation constructed all hydroacoustic systems used to estimate smolt numbers in Bristol Bay river systems. Ten upward-facing transducers were housed in 3.03-m long arrays set on the river bottom and connected by coaxial cable to a control unit located on shore. Arrays on the Egegik, Ugashik, Nuyakuk, and Wood Rivers were placed in similar locations to previous years. Location of the hydroacoustic equipment on the Kvichak River during 1989 was approximately one kilometer downstream from the site used during the previous 15 years (See Appendix A). All arrays at each project site were removed from the rivers at the end of the field season--determined by the cessation of smolt migration--or budget constraints.

Hydroacoustic systems were factory calibrated to record one count for a specified amount of fish biomass (41.5 g for all projects) passing through each transducer beam during a given time period. Individual arrays were ranged independently, which allowed the operator to set the counting range as near the surface as possible. Most smolt migrate in the upper portion of the water column. The counting range was set to record counts to within 1 to 2 cm of the water surface to avoid counting debris or air entrapped on the surface.

Sources of false counts such as boats, wind, rain, debris, etc. were noted and hydroacoustic equipment disabled whenever false counts or false count conditions were detected. Known false counts were subtracted from hourly totals and linear interpolations were used to estimate counts missed while equipment was disabled. Each control unit had a disable switch so the person monitoring the equipment could manually stop tabulation of known false counts (i.e., counts due to floating debris, ice, entrained air from high winds or rain, etc.). The control unit automatically recorded and stored the length of time the system was disabled.

The control unit had manual settings for adjusting printing intervals for accumulated counts, transducer pulse rate, and the portion of the water column monitored. Transducer signal characteristics were visually monitored with an oscilloscope. All smolt counters, except those at Wood and Ugashik Rivers, monitored three transducer arrays. The Wood River and Ugashik units monitored two arrays. An additional switching box was added to the Wood River system which allowed a combination of any two of the arrays to be monitored by the counter.

### *Project Locations*

The counting site on the Kvichak River was located 6 km below the outlet of Lake Iliamna (Figure 1). River width at the counting site was 123 m. Three transducer arrays, referred to as *inshore*, *center*, and *offshore*, were anchored 23 m, 55 m, and 72 m from the east bank (See Appendix A). The counting site on the Egegik River was located 4 km below the outlet of Becharof Lake. River width at the counting site was 104 m. The inshore, center, and offshore arrays were anchored 40 m, 55 m, and 67 m from the south bank. The counting site on the Ugashik River was located 50 m below the outlet of Lower Ugashik Lake. River width at the counting site was 43 m. Because of the relatively narrow width of the channel, only two arrays were used. The inshore and offshore arrays were anchored 23 m and 28 m from the north bank. The counting site on the Wood River was located 1 km below the outlet of Lake Aleknagik. River width at the counting site was 113 m. Arrays I, II, III, and IV were anchored 20 m, 35 m, 54 m, and 62 m from the north bank. The counting site on the Nuyakuk River was located 3.5 km below the outlet of Tikchik Lake. River width at the counting site was 148 m. The inshore, center and offshore arrays were initially anchored 30 m, 54 m, and 66 m from the south bank. On June 17, the arrays in the Nuyakuk River were pulled several meters downstream by ice coming out of Tikchik Lake. The new distances for the inshore, center, and offshore were 24 m, 42 m, and 59 m from the south bank.

### *Estimation of Smolt Numbers*

The process of estimating smolt numbers was divided into three major steps: (1) determining total fish biomass migrating past the study site; (2) sampling the migrating fish population to estimate species, age, weight, and length composition; and (3) converting fish biomass into numbers of smolt by age and species.

#### Biomass Estimation

Fish biomass was estimated with continually monitored hydroacoustic equipment. Signal pulse rate of the smolt counter was set to correspond with the river velocity measured over one array (referred to as the velocity index array). Because velocities of Egegik and Wood Rivers are influenced by tides, a Marsh-McBirney[2] flow meter was anchored directly behind the velocity index array to continuously monitor river velocities. The smolt counters at Egegik and Wood Rivers were adjusted every 15 to 30 min to account for changes in river velocity. A Marsh-McBirney meter was also used to monitor river velocities over the Nuyakuk River index array, and the signal pulse rate of the counter was adjusted daily at 1200 hours. Velocities of Kvichak and Ugashik Rivers are more stable than the

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[2,3] Mention of a product name does not constitute an endorsement by the Department of Fish and Game.

other rivers. River velocities at these sites were measured periodically with a Gurley[3] flow meter and the counters adjusted accordingly. To account for differences in river velocities between the index array and the remaining arrays, readings over each array were taken at specified intervals and velocity correction factors were then calculated:

$$vcf_i = \frac{v_i}{v_{index}} \quad , \tag{1}$$

where:

$vcf_i$ = velocity correction factor for array $i$; and

$v_i$ = velocity over array $i$; and

$v_{index}$ = velocity over the velocity index array.

Using these correction factors, adjustments for differences in river velocity were made to daily counts for each array:

$$ac_{i,z} = c_{i,z}\, vcf_i \quad , \tag{2}$$

where:

$ac_{i,z}$ = adjusted counts for array $i$ on day $z$; and

$c_{i,z}$ = counts for array $i$ on day $z$.

All sonar arrays, except those at Wood River, were used to monitor fish biomass 24 hours per day, so daily counts for each array represented actual sonar counts. The counter at Wood River was designed to simultaneously control only two of the four arrays used. Array I (the index array) was continuously monitored by the unit. The other three arrays were each monitored for 15-min periods each hour. Consequently, total daily counts for array I were known, while those for arrays II, III, and IV were estimated from the 15 minute per hour counting period:

$$\hat{hc}_{i,z,k} = \sum_{1=1}^{p} (pc_{i,z,k,1} \frac{4}{p}) \quad , and \tag{3}$$

$$\hat{e}_{i,z} = \sum_{1=1}^{24} \hat{hc}_{i,z,k} \quad , \qquad (4)$$

where:

$\hat{hc}_{i,z,k}$ = hourly count for array $i$, day $z$, and hour $k$;

$\hat{c}_{i,z,k}$ = estimated counts for array $i$, day $z$, and hour $k$;

$pc_{i,z,k,l}$ = sonar counts for array $i$, day $z$, hour $k$, and counting period $l$; and

p = the number of 15-min periods that array $i$ was monitored during hour $k$ and day $z$.

If an array was not monitored during an hour, counts were linearly interpolated using estimated counts from the previous and following hours. Estimated $\hat{c}_{i,z}$ for Wood River was used in equation (2).

The width of river monitored by each array depended on array length (3.03 m), water depth over the array, and transducer signal beam width:

$$l_{i,z} = 3.03 + 2\ (d_{i,z} \tan \frac{bw}{2}) \quad , \qquad (5)$$

where:

$l_{i,z}$ = width of river monitored by array $i$ on day $z$;

$d_{i,z}$ = water depth over array $i$ on day $z$; and

bw = transducer beam width, in degrees (9° for all transducers).

Arrays were placed perpendicular to the river current, at locations similar to those in previous years. Distances from each array to a reference point on one of the river banks were measured. Estimates of the inshore and offshore limits of smolt passage were obtained with side-scanning hydroacoustic equipment. At sites where three arrays were used, distances between the following locations were calculated: (1) inshore limit of smolt passage to first array ($D_1$); (2) first to second array ($D_2$); (3) second to third array ($D_3$); (4) third array to offshore limit of smolt passage ($D_4$).

The biomass of fish passing the counting site was estimated as follows:

$$\hat{B}_z = \frac{1}{2} D_1 \left(\frac{ac_{1,z}}{1_{1,z}}\right) + \sum_{i=2}^{na} \frac{1}{2} D_i \left(\frac{ac_{i-1,z}}{1_{i-1,z}} + \frac{ac_{i,z}}{1_{i,z}}\right) \qquad (6)$$

$$+\frac{1}{2} d_{na+1} \left(\frac{ac_{na,z}}{1_{na,z}}\right)$$

where:

$\hat{B}_z$ = estimated biomass on day $z$;

$D_i$ = the distance for interval $i$; and

na = number of transducer arrays used.

Age, Weight, Length Estimation

Data on age, weight, and length of sockeye smolt were obtained from samples captured in fyke nets. Smolt weight (g) and length (mm from tip-of-snout to fork-of-tail) were measured, while age was determined from scales mounted on glass slides which were read using a microfiche reader. Smolt were designated as age I, II, or III depending on the number of freshwater annuli. Parent year escapements responsible for smolt outmigrating in 1989 were 1987 for age-I smolt, 1986 for age-II smolt, and 1985 for age-III smolt.

The dominant age group of smolt from the Kvichak, Egegik, and Ugashik rivers varies annually. Sample size goals for those rivers were 400 smolt per day. Based on the worst case scenario for the binomial proportions of the two major age groups; i.e., age-I and -II smolt each comprising 50%, a sample size of 400 smolt would simutaneously estimate the true percentage of each age class within 5 percentage points 90% of the time (Goodman; Cochran 1977). Whenever the daily goal of 400 smolt was not obtained, smolt from subsequent days were combined until a total of at least 400 was reached.

Mean length of smolt, which is strongly correlated with age, has been shown to differ among fyke net samples from the same day (Minard and Brandt 1986). To ensure that age composition estimates for each day were representative of the population migrating past the sonar sites, attempts were made to obtain 100 smolt from each of six different fyke net catches each day. Weight and age of smolt are strongly correlated to length, so to reduce the time and cost of data collection, all smolt collected each day were measured for length (up to a maximum of 600), while only 100 of those smolt were weighed and aged (B. Bue, ADF&G, personal communication).

Age-I smolt are preponderant each year in the migration from the Nuyakuk River (1983-1988 average = 96.6%); consequently, the sample goal was lower. The sample goal for the Nuyakuk River was 300 smolt per day. Based on binomial proportions for the two age groups, a sample size of 300 smolt would simultaneously estimate the true percentage of each age class within 5 percentage points, at least 95% of the time (Goodman 1965; Cochran 1977). As with the Kvichak, Egegik, and Ugashik projects, all smolt collected each day were measured for length, while only 100 of those were weighed and aged.

Age-I smolt are also preponderant each year in the migration from the Wood River (1982-1988 average = 93.7%); consequently, the sample goal was also lower. Because smolt migration patterns for the Wood River made it difficult to consistently collect quantities of smolt, only 120 smolt were collected each day. Smolt from subsequent days were pooled into a sample of 200. Based on binomial proportions for the two age groups, a sample size of 200 smolt would simultaneously estimate the true percentage of each age class within 5 percentage points, at least 95% of the time (Goodman 1965; Cochran 1977). All 120 smolt per day were sampled for age, weight, and length.

Weight was estimated for smolt measured only for length using a least squares linear regression. Based on paired weight-length data obtained from smolt sampled for age, weight, and length (Ricker 1975), weights were estimated for those smolt measured only for length.

$$W_j = \propto L_j^{\beta} \quad , \tag{7}$$

where:

$W_j$ = weight of an age $j$ smolt; and

$L_j$ = fork length of an age $j$ smolt: and

$\alpha$ and $\beta$ = parameters which determine the y-axis intercept and the slope of the line.

Age was estimated for the smolt measured only for length utilizing an age-length key. (Bue and Eggers 1989). The age-length key used length to categorize age-I or -II sockeye salmon smolt by determining a discriminant length that minimized classification error. This discriminant length was chosen such that the number of age-I smolt classified as age-II smolt was equal to the number of age-II smolt classified as age-I smolt.

Due to the variability of age and size composition estimates among subsamples (fyke net catches) taken the same day, daily mean weight and age proportions were estimated as the mean of subsampled values:

$$\hat{W} = \frac{\sum_{k=1}^{m} \frac{\sum w_k}{n_k}}{m} , \quad (8)$$

where:

$\hat{W}$ = estimated mean weight of smolt during a sample period;

$m$ = number of subsamples collected during a sampling period;

$w_k$ = observed weights from subsample $k$; and

$n_k$ = number of observations in subsample $k$; and

$$\hat{P}_j = \frac{\sum_{k=1}^{m} \frac{(n_{j,k})}{n_k}}{m} , \quad (9)$$

where:

$\hat{P}_j$ = estimated proportion of age $j$ during a sample period; and

$n_{j,k}$ = number of observations of age $j$ in subsample $k$.

Estimation of Smolt Numbers

Numbers of smolt by age were estimated by combining biomass estimates with estimates of age and weight composition. Mean weight of smolt was used to convert estimates of biomass per count into estimates of smolt per count:

$$\hat{SPC} = \frac{BPC}{\hat{W}} , \quad (10)$$

where:

$\hat{SPC}$ = estimated number of smolt per sonar count; and

BPC = biomass per count (41.5 g per count).

the estimated number of smolt for each day was the product of smolt per count and estimated biomass:

$$\hat{N}_z = \hat{B}_z \, S\hat{P}C \quad , \tag{11}$$

where:

$\hat{N}_z$ = estimated number of smolt in population on day $z$.

The estimated number of smolt for each day were then apportioned into age classes:

$$\hat{N}_{j,z} = \hat{N}_z \, \hat{P}_j \quad , \tag{12}$$

where:

$\hat{N}_{j,z}$ = estimated number of smolt of age $j$ on day $z$.

Finally, daily estimates of smolt numbers were summed to provide season totals of smolt passing the site:

$$\hat{N}_{tot} = \Sigma \hat{N}_z \quad , and \tag{13}$$

$$\hat{N}_{jtot} = \Sigma \hat{N}_{j,z} \quad , \tag{14}$$

where:

$\hat{N}_{tot}$ = estimated total number of smolt which passed site during season; and

$\hat{N}_{jtot}$ = estimated number of smolt of age $j$ which passed the sonar site during the season.

### *Incidence of Triaenophorus crassus*

The presence or absence of the cestode *Trianenophorus crassus* was determined by gross external examination for small bumps underneath the skin for each Wood River smolt examined for age-weight-length data.

### *Climatological Data Collection*

Climatological data were recorded at each counting site. Observations of sky conditions and measurements of wind direction, wind velocity (km/h), daily precipitation (mm), air temperature (°C), and water temperature (°C), were recorded at 0800 and 2000 hours daily.

## RESULTS

### *Kvichak River*

A total of 2,770,156 sonar counts were recorded at the Kvichak River site from May 19 through June 15, 1989 (Table 1: Appendix A). Most counts were recorded over the offshore array (53.4%). Few counts were recorded over the inshore array (2.8%). Daily sonar counts were greatest from May 29 through June 6, during which 78% of the counts were recorded. Side-scanning sonar information at the counting site indicated that most smolt migrated within a 106 m corridor which began 12.2 m from the east bank. River velocities over the center (index) array ranged from 1.2 to 1.3 m/s. Velocity correction factors for the three arrays are provided below.

| | Inshore | Center | Offshore |
|---|---|---|---|
| May 19 - May 27 | 0.47 | 1.00 | 1.03 |
| May 28 - June 9 | 0.41 | 1.00 | 1.02 |
| June 8 - June 16 | 0.91 | 1.00 | 1.04 |

An estimated 153,464,216 sockeye salmon smolt migrated from the Kvichak River in 1989 based on sonar counts (Table 2). Age-I smolt (1987 brood year) comprised 95.5% of the total migration. The daily percentages of age-I and age-II smolt remained nearly the same throughout the duration of the project. The mean weight of smolt was also similar throughout the field season, and consequently the estimated number of smolt per count remained similar (Table 3). Total smolt production from the 1986 spawning escapement of 1,179,322 sockeye salmon was 16.9 smolt per spawner (Table 4). Marine survival for age-I smolt has averaged 11.8% (1969-1985 brood years,) and 12.4% for age-II smolt (1968-1984 brood years; Table 5).

Age, weight, and length data were collected from 1,188 sockeye salmon smolt in 1989 (Table 6). Mean weights of age-I, -II and -III smolt were 5.5 g, 10.8 g, and 9.5 g. Mean lengths of age-I, -II, and -III smolt were 85 mm, 108 mm, and 105 mm. Age-I, -II, and -III Kvichak River smolt in 1989 were similar (NSC = nonstatistical comparison) in length and weight to the 1955-1988 average (Table 7). An additional 5,786 smolt were measured for length only (Table 8). Mean smolt length remained similar throughout the 1989 field season; one discriminant length based on length and weight-length relationships for both age groups was used to determine proportions of age groups.

River and weather conditions were recorded at the counting site from May 19 through June 16 (Table 9). Operation of the project was not greatly affected by weather conditions in 1989. Mean water temperature during the project was 5.8° C (range 3.0-8.8°C), which was similar (NSC) to the 1963-1988 mean of 5.6°C (Table 10). Mean water temperature during the peak days of the smolt migration on May 29 and June 3 was 5.0 and 6.0°C.

## *Egegik River*

A total of 4,955,332 sonar counts were recorded at the Egegik River counting site from May 20 through June 9, 1989 (Table 11). Most counts occurred over the inshore array (42.6%). Daily sonar counts were greatest from May 25 to 29 when 79.9% of the counts were recorded. Side-scanning sonar information collected at the counting site during previous years (Cross et al. 1990) indicated that most smolt migrated past in a 73-m corridor which began 9.1 m from the south bank. River velocities over the inshore (index) array ranged from 0.46 to 0.70 m/s. Velocity correction factors for the inshore, center, and offshore arrays are provided below.

| | Inshore | Center | Offshore |
|---|---|---|---|
| May 20 - May 27 | 1.00 | 1.32 | 1.29 |
| May 28 - June 3 | 1.00 | 1.33 | 1.27 |
| June 4 - June 9 | 1.00 | 1.10 | 1.00 |

An estimated 99,886,786 sockeye salmon smolt migrated from the Egegik River in 1989 based on sonar counts (Table 12). Age-I smolt comprised 72.5% of the total migration. The daily percentage of age-II smolt decreased throughout the duration of the migration. The mean weight of smolt decreased throughout the season, consequently the estimated number of smolt per count increased (Table 13). Total smolt production from the 1986 spawning escapement of 1,151,320 sockeye salmon was 55.13 smolt per spawner (Table 14). Average marine survival has been 25.7% for age-I smolt (1980-1985 brood years) and 26.0% for age-II smolt (1979-1984 brood years; Table 15).

Age, weight, and length data were collected from 662 sockeye salmon smolt in 1989 (Table 16). Mean weights of age-I, -II, and -III smolt were 8.9 g, 15.4 g, and 21.1 g. Mean lengths of age-I, -II, and -III smolt were 99 mm, 119 mm, and 135 mm. Age-I smolt were slightly smaller (NSC) than the historical average, while age-II and -III smolt were similar to the historical average (Table 17). An additional 3,360 smolt were measured for length only (Table 18). Mean smolt length remained similar throughout the 1989 field season; one discriminant length based on length and weight-length relationships for both age groups was used to determine proportions of age groups.

River and weather conditions were recorded at the counting site from May 21 through June 10 (Table 19). Mean water temperature during the 1989 field season was 5.2°C (range 3.0-11.0°C), which was lower (NSC) than the 1981-1988 average of 6.2°C (Table 20).

## *Ugashik River*

A total of 15,341,442 sonar counts were recorded at the Ugashik River sonar counting site from May 22 through June 15, 1989 (Table 21). Most counts were recorded over the offshore array (74.8%). Daily sonar counts were greatest on May 25 and 31, when 35.4% of the counts were recorded. Side-scanning sonar information indicated that most smolt migrated past the sonar site in a 15-m corridor which began 18 m from the north bank. River velocities over the inshore and offshore arrays ranged from 1.3 to 2.2 m/s. Velocity correction factors for the inshore and offshore arrays are provided below.

| | Inshore | Offshore |
|---|---|---|
| May 22 - May 29 | 1.00 | 1.10 |
| May 30 - June 1 | 1.00 | 1.10 |
| June 2 - June 3 | 1.00 | 0.96 |
| June 4 - June 11 | 1.00 | 0.96 |
| June 12 - June 15 | 1.00 | 1.12 |

An estimated 126,298,122 sockeye salmon smolt migrated from the Ugashik River in 1989 based on sonar counts (Table 22). Age-I smolt (1987 brood year) comprised 74.0% of the total migration. Age-I smolt predominated throughout the entire counting period, with one notable exception occurring on May 29 when age-II smolt comprised 59.6% of the daily outmigration. The estimated number of smolt per sonar count ranged from 4.4 to 6.7 (Table 23). Total smolt production from the 1986 spawning escapement of 1,001,493 sockeye salmon was 214.68 smolt per spawner (Table 24). This production rate was the greatest of any year since the beginning of monitoring smolt outmigration in 1981. Average marine survival has been 9.6% for age-I smolt (1981-1985 brood years) and 13.8 for age-II smolt (1980-1984 brood years; Table 25).

Age, weight, and length data were collected from 1,898 sockeye salmon smolt in 1989 (Table 26). Mean weights of age-I and -II smolt were 6.5 g and 10.7 g. Mean lengths for age-I and -II smolt were 90 mm and 108 mm. Age-I smolt were similar to, and age-II smolt smaller than (NSC) the 1958-1988 average. (Table 27). An additional 10,117 smolt were sampled for length only (Table 28). Mean smolt length remained similar throughout the 1989 season; one discriminant length based on length and weight-length relationships for both age groups was used to determine proportions of age groups.

River and weather conditions were recorded at the counting site from May 21 through June 16 (Table 29). Average water temperature was 5.8°C (range 3.0-8.8°C), which was similar (NSC) to the 1983-1988 average of 6.0°C (Table 30).

## *Wood River*

A total of 864,525 sonar counts were recorded at the Wood River counting site from June 9 through August 6 (Table 31). Ice from Lake Aleknagik prevented placement of the arrays in the river until June 9. The greatest count for a

single day occurred on June 12, indicating that smolt migration probably began prior to deployment of the sonar equipment. Consequently, the total number of sonar counts and resulting estimate of smolt migration should be considered a minimum. The distribution of counts over the four arrays was 23.3% over array I, 29.0% over array II, 23.0% over array III, and 24.7% over array IV. This pattern was similar to that observed in past years (Table 32). Side-scanning sonar data to describe lateral smolt distribution was not collected in 1989. Lateral distribution was assumed to be a function of river width and depth, which were measured and recorded during times when tidal influence was minimal. Based on those measurements, smolt were assumed to migrate within a 94-m corridor which began 3.2 m from the north bank.

River velocity at the counting site varied greatly each day because of tidal influence. During periods of extreme high tide, the direction of river flow actually reversed. The hydroacoustic equipment was disabled during tide reversals because smolt were assumed to not be migrating downriver. The counting equipment was also disabled during times when flow rates were less than 0.30 m/s. The signal pulse rate for the counter was mistakenly set at one-half the river velocity from June 10 through July 16. The velocity correction factor for this time period was doubled to compensate for this error (Table 33). River velocity during times of counting ranged from 0.98 m/s to 1.82 m/s over the inshore (index) array. Velocity correction factors for the arrays were calculated 13 times during the season (Table 33).

An estimated 41,229,040 sockeye salmon smolt migrated from the Wood River in 1989 based on sonar counts (Table 34). Age-I smolt (1987 brood year) comprised 91.3% of the total and predominated throughout the entire counting period. Mean weight of the age-I smolt generally increased throughout the season, and the estimated number of smolt per sonar count decreased (Table 35). Rogers (1988) found late season migrants from Wood River were typically larger than smolt from earlier in the season.

Total smolt production from the 1986 spawning escapement of 818,652 sockeye salmon was 53.02 smolt per spawner (Table 36). Production from the 1973-1985 brood years has ranged from a low of 12.29 smolt per spawner (1980 brood year) to a high of 111.83 smolt per spawner (1977 brood year). Average marine survival has been 7.1% for age-I smolt (1973-1985 brood years), and 6.5% for age-II smolt (1972-1984 brood years; Table 37).

Age, weight, and length data were collected from 2,583 sockeye salmon smolt in 1989 (Table 38). Mean weights of age-I and -II smolt were 7.8 g and 9.1 g. Mean lengths of age-I and -II smolt were 91 mm and 98 mm. Mean length and weight of 1989 age-I smolt were larger, and age-II smolt were similar (NSC) to the 1951-1988 average (Table 39). Infection by *Triaenophorus crassus* occurred in 65.6% of 2,528 age-I smolt that were examined and in 44.9% of 98 age-II smolt (Table 40). The incidence of *T. crassus* has generally increased (NSC) since 1978 (Table 41).

River and weather conditions were recorded at the counting site from June 9 through August 7 (Table 42). Mean water temperature at the outlet of Lake Aleknagik during the season was 9.3°C (range 5.0-12.5°C), which was slightly warmer (NSC) than the 1975-1988 average of 8.2°C (Table 43).

*Nuyakuk River*

A total of 164,192 sonar counts were recorded at the Nuyakuk River counting site from May 29 through June 23, 1989 (Table 44). Counts were distributed similarly over the center (43.6%) and offshore arrays (41.6%). Daily sonar counts were greatest June 12-16, during which 68.9% of the counts were recorded. Side-scanning sonar information collected during previous years (Cross et al. 1990) indicated the water depth that determined the limits of smolt passage (distance from shore) for the Nuyakuk River site. From May 29 through June 16, most smolt migrated within an 81-m corridor which began 12.2 m from the south bank. The corridor of smolt passage after ice shifted the arrays downstream on June 17 was 73 m, and began 11 m from the south bank. River velocity over the inshore (index) array was determined daily at 1200 hours and ranged from 0.73 to 1.37 m/s. River velocity was measured every 5 days over the center and offshore arrays to determine velocity correction factors (Table 45).

An estimated 6,154,491 sockeye salmon smolt migrated from the Nuyakuk River in 1989 based on sonar counts (Table 46). Age-I smolt (1987 brood year) comprised 90.8% of the 1989 total migration and predominated throughout the counting period. The estimated number of smolt per count ranged from 5.4 to 4.7 (Table 47). Total smolt production from the 1986 spawning escapement of 821,898 sockeye salmon was 10.80 smolt per spawner, which was the lowest production observed since the beginning of the project (Table 48). Average marine survival has been 5.1% for age-I smolt (1981-1984 brood years) and 12.4% for age-II smolt (1980-1983 brood years; Table 49).

Age, weight, and length data was collected from 1,357 sockeye salmon smolt in 1989 (Table 50). Mean weights of age-I and -II smolt were 5.0 g and 7.5 g. Mean lengths age-I and -II smolt were 82 mm and 96 mm. Age-I and -II smolt in 1989 were larger (NSC) in length and weight than the 1978-1988 average (Table 51). An additional 2,144 smolt were measured for length only (Table 52). Mean smolt length remained similar throughout the 1989 season; one discriminant length based on length and weight-length relationships for both age groups was used to determine proportions of age groups.

River and weather conditions were recorded at the Nuyakuk counting site from May 29 through June 23 (Table 53). Nuyakuk Lake was covered with ice when the sonar project began, and ice and debris drifting downstream was commonly observed through early to mid-June. Mean air and water temperatures during the project were 9.8°C (range 5.0-20.0°C) and 4.5°C (range 2.5-7.0°C).

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Table 1. Sonar counts recorded from three arrays each with 10 transducers at the sockeye salmon smolt counting site on the Kvichak River, 1989.

| | Sonar Counts | | | |
|---|---|---|---|---|
| | Transducer Array | | | |
| Date[a] | Inshore | Center | Offshore | Total |
| 5 19 | 23 | 39 | 57 | 119 |
| 5 20 | 83 | 41 | 66 | 190 |
| 5 21 | 17 | 69 | 70 | 156 |
| 5 22 | 11 | 91 | 12 | 114 |
| 5 23 | 37 | 25 | 41 | 103 |
| 5 24 | 102 | 0 | 38 | 140 |
| 5 25 | 53 | 65 | 39 | 157 |
| 5 26 | 50 | 263 | 207 | 520 |
| 5 27 | 113 | 397 | 119 | 629 |
| 5 28 | 551 | 10,716 | 13,837 | 25,104 |
| 5 29 | 4,259 | 202,656 | 234,047 | 440,962 |
| 5 30 | 1,516 | 58,790 | 61,258 | 121,564 |
| 5 31 | 13,603 | 128,155 | 101,859 | 243,617 |
| 6 01 | 709 | 3,3104 | 43,228 | 77,041 |
| 6 02[b] | 1,389 | 115,080 | 151,582 | 268,051 |
| 6 03 | 8,686 | 207,048 | 259,370 | 475,104 |
| 6 04 | 4,117 | 115,600 | 169,688 | 289,405 |
| 6 05 | 1,259 | 15,066 | 14,440 | 30,765 |
| 6 06 | 14,402 | 51,906 | 150,573 | 216,881 |
| 6 07 | 2,380 | 9,093 | 8,773 | 20,246 |
| 6 08 | 873 | 25,256 | 24,995 | 5,1124 |
| 6 09 | 3,806 | 97,100 | 117,505 | 218,411 |
| 6 10 | 1,961 | 31,914 | 22,997 | 56,872 |
| 6 11 | 1,453 | 36,551 | 44,372 | 82,376 |
| 6 12 | 4,477 | 27,646 | 26,335 | 58,458 |
| 6 13 | 3,538 | 15,541 | 9,546 | 28,625 |
| 6 14 | 7,914 | 23,043 | 16,532 | 47,489 |
| 6 15 | 1,397 | 7,123 | 7,413 | 15,933 |
| Total | 78,779 | 1,212,378 | 1,478,999 | 2,770,156 |
| Percent | 2.8 | 43.8 | 53.4 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

[b] Interpolated data for hours 1200-1800, and 2000 on June 2.

Table 2. Daily number of sockeye salmon smolt migrating seaward, estimated with hydroacoustic equipment, Kvichak River, 1989.

| | Age I | | | Age II | | | Age III | | | All Ages | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 5 19 | 5,890 | 97.7 | 5,890 | 139 | 2.3 | 139 | 0 | 0.0 | 0 | 6,029 | 6,029 |
| 5 20 | 7,733 | 97.7 | 13,623 | 183 | 2.3 | 322 | 0 | 0.0 | 0 | 7,916 | 13,945 |
| 5 21 | 8,010 | 97.7 | 21,633 | 190 | 2.3 | 512 | 0 | 0.0 | 0 | 8,200 | 22,145 |
| 5 22 | 5,246 | 97.7 | 26,879 | 124 | 2.3 | 636 | 0 | 0.0 | 0 | 5,370 | 27,515 |
| 5 23 | 4,485 | 97.7 | 31,364 | 106 | 2.3 | 742 | 0 | 0.0 | 0 | 4,591 | 32,106 |
| 5 24 | 4,376 | 97.7 | 35,740 | 103 | 2.3 | 845 | 0 | 0.0 | 0 | 4,479 | 36,585 |
| 5 25 | 6,533 | 97.7 | 42,273 | 155 | 2.3 | 1,000 | 0 | 0.0 | 0 | 6,688 | 43,273 |
| 5 26 | 26,243 | 97.7 | 68,516 | 623 | 2.3 | 1,623 | 0 | 0.0 | 0 | 26,866 | 70,139 |
| 5 27 | 28,271 | 97.7 | 96,787 | 671 | 2.3 | 2,294 | 0 | 0.0 | 0 | 28,942 | 99,081 |
| 5 28 | 1,369,874 | 97.7 | 1,466,661 | 32,535 | 2.3 | 34,829 | 0 | 0.0 | 0 | 1,402,409 | 1,501,490 |
| 5 29 | 24,127,127 | 97.7 | 25,593,788 | 573,043 | 2.3 | 607,872 | 0 | 0.0 | 0 | 24,700,170 | 26,201,660 |
| 5 30 | 5,572,981 | 90.8 | 31,166,769 | 557,605 | 9.1 | 1,165,477 | 10,439 | 0.2 | 10,439 | 6,141,025 | 32,342,685 |
| 5 31 | 10,626,486 | 90.8 | 41,793,255 | 1,063,234 | 9.1 | 2,228,711 | 19,906 | 0.2 | 30,345 | 11,709,626 | 44,052,311 |
| 6 01 | 3,355,989 | 86.2 | 45,149,244 | 539,529 | 13.9 | 2,768,240 | 0 | 0.0 | 30,345 | 3,895,518 | 47,947,829 |
| 6 02 | 11,730,605 | 86.2 | 56,879,849 | 1,885,883 | 13.9 | 4,654,123 | 0 | 0.0 | 30,345 | 13,616,488 | 61,564,317 |
| 6 03 | 24,708,053 | 93.9 | 81,587,902 | 1,610,708 | 6.1 | 6,264,831 | 0 | 0.0 | 30,345 | 26,318,761 | 87,883,078 |
| 6 04 | 17,527,758 | 99.2 | 99,115,660 | 134,231 | 0.8 | 6,399,062 | 0 | 0.0 | 30,345 | 17,661,989 | 105,545,067 |
| 6 05 | 1,725,111 | 99.3 | 100,840,771 | 12,860 | 0.7 | 6,411,922 | 0 | 0.0 | 30,345 | 1,737,971 | 107,283,038 |
| 6 06 | 12,753,080 | 99.3 | 113,593,851 | 95,076 | 0.7 | 6,506,998 | 0 | 0.0 | 30,345 | 12,848,156 | 120,131,194 |
| 6 07 | 1,000,175 | 97.2 | 114,594,026 | 28,917 | 2.8 | 6,535,915 | 0 | 0.0 | 30,345 | 1,029,092 | 121,160,286 |
| 6 08 | 2,729,315 | 97.2 | 117,323,341 | 78,911 | 2.8 | 6,614,826 | 0 | 0.0 | 30,345 | 2,808,226 | 123,968,512 |
| 6 09 | 12,840,315 | 99.5 | 130,163,656 | 63,227 | 0.5 | 6,678,053 | 0 | 0.0 | 30,345 | 12,903,542 | 136,872,054 |
| 6 10 | 3,159,640 | 97.8 | 133,323,296 | 69,754 | 2.2 | 6,747,807 | 0 | 0.0 | 30,345 | 3,229,394 | 140,101,448 |
| 6 11 | 4,945,408 | 99.5 | 138,268,704 | 25,850 | 0.5 | 6,773,657 | 0 | 0.0 | 30,345 | 4,971,258 | 145,072,706 |
| 6 12 | 3,309,621 | 99.3 | 141,578,325 | 22,659 | 0.7 | 6,796,316 | 0 | 0.0 | 30,345 | 3,332,280 | 148,404,986 |
| 6 13 | 1,552,150 | 99.3 | 143,130,475 | 10,626 | 0.7 | 6,806,942 | 0 | 0.0 | 30,345 | 1,562,776 | 149,967,762 |
| 6 14 | 2,563,526 | 99.3 | 145,694,001 | 17,551 | 0.7 | 6,824,493 | 0 | 0.0 | 30,345 | 2,581,077 | 152,548,839 |
| 6 15 | 909,153 | 99.3 | 146,603,154 | 6,224 | 0.7 | 6,830,717 | 0 | 0.0 | 30,345 | 915,377 | 153,464,216 |
| | 146,603,154 | 95.5 | | 6,830,717 | 4.5 | | 30,345 | 0.0 | | 153,464,216 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 3. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Kvichak River, 1989.

| Date[a] | Mean Weight of Smolt (g) | Smolt per Count |
|---|---|---|
| 5 19 | 5.7 | 7.3 |
| 5 20 | 5.7 | 7.3 |
| 5 21 | 5.7 | 7.3 |
| 5 22 | 5.7 | 7.3 |
| 5 23 | 5.7 | 7.3 |
| 5 24 | 5.7 | 7.3 |
| 5 25 | 5.7 | 7.3 |
| 5 26 | 5.7 | 7.3 |
| 5 27 | 5.7 | 7.3 |
| 5 28 | 5.7 | 7.3 |
| 5 29 | 5.7 | 7.3 |
| 5 30 | 6.2 | 6.7 |
| 5 31 | 6.2 | 6.7 |
| 6 01 | 6.4 | 6.5 |
| 6 02 | 6.4 | 6.5 |
| 6 03 | 5.7 | 7.3 |
| 6 04 | 5.3 | 7.9 |
| 6 05 | 5.4 | 7.7 |
| 6 06 | 5.4 | 7.7 |
| 6 07 | 5.7 | 7.3 |
| 6 08 | 5.7 | 7.3 |
| 6 09 | 5.4 | 7.8 |
| 6 10 | 5.4 | 7.6 |
| 6 11 | 5.3 | 7.8 |
| 6 12 | 5.5 | 7.6 |
| 6 13 | 5.5 | 7.6 |
| 6 14 | 5.5 | 7.6 |
| 6 15 | 5.5 | 7.6 |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 4. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1956-1987 brood years, Kvichak River.

| Brood Year | Total Spawning Escapement | Number of Smolt Produced | | | | | | | | | Per Spawner |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age I | (%[a]) | Age II | (%[a]) | Age III | (%[a]) | Total | |
| | | Estimates of smolt numbers based upon fyke net catches | | | | | | | | | |
| 1956 | 9,443,318 | 3,267,274 | (54) | 2,777,960 | (46) | 0 | | 6,045,234 | 0.64 |
| 1957 | 2,842,810 | 85,916 | (13) | 552,603 | (87) | 0 | | 638,519 | 0.23 |
| 1958 | 534,785 | 61,400 | (86) | 10,126 | (14) | 0 | | 71,526 | 0.13 |
| 1959 | 680,000 | 26,038 | (27) | 72,180 | (73) | 0 | | 98,218 | 0.14 |
| 1960 | 14,630,000 | 1,130,820 | (22) | 4,116,093 | (78) | 0 | | 5,246,913 | 0.36 |
| 1961 | 3,705,849 | 113,338 | ( 7) | 1,603,464 | (93) | 0 | | 1,716,802 | 0.46 |
| 1962 | 2,580,884 | 458,122 | (21) | 1,748,178 | (79) | 0 | | 2,206,300 | 0.86 |
| 1963 | 338,760 | 64,377 | (73) | 23,377 | (27) | 0 | | 87,754 | 0.27 |
| 1964 | 957,120 | 252,384 | (53) | 222,528 | (47) | 0 | | 474,912 | 0.50 |
| 1965 | 24,325,926 | 2,866,214 | (34) | 5,475,362 | (66) | 0 | | 8,341,576 | 0.34 |
| 1966 | 3,775,184 | 648,321 | (55) | 541,017 | (45) | 0 | | 1,189,338 | 0.32 |
| 1967 | 3,216,208 | 594,327 | (67) | 298,282 | (33) | 0 | | 892,609 | 0.28 |
| 1968 | 2,557,440 | 185,356 | | | | | | | |
| | | Estimates of smolt numbers based upon sonar techniques | | | | | | | | | |
| 1968 | | | | 5,959,383 | | 0 | | - | - |
| 1969 | 8,394,204 | 85,723,430 | (61) | 54,159,340 | (39) | 0 | | 139,882,770 | 16.66 |
| 1970 | 13,935,306 | 464,219 | (<1) | 191,842,930 | (98) | 2,918,768 | (1) | 195,225,917 | 14.01 |
| 1971 | 2,387,392 | 5,123,400 | (19) | 21,423,246 | (81) | 0 | | 26,546,646 | 11.12 |
| 1972 | 1,009,962 | 2,740,610 | | - | | - | | - | - |
| 1973 | 226,554 | - | | 3,031,287 | | 0 | | - | - |
| 1974 | 4,433,844 | 108,356,892 | (49) | 114,269,848 | (51) | 0 | | 222,626,740 | 50.21 |
| 1975 | 13,140,450 | 78,308,251 | (27) | 213,364,470 | (73) | 0 | | 291,672,721 | 22.20 |
| 1976 | 1,965,282 | 32,226,544 | (55) | 26,423,348 | (45) | 0 | | 58,649,892 | 29.84 |
| 1977 | 1,341,144 | 28,758,191 | (73) | 10,410,467 | (27) | 0 | | 39,168,658 | 29.21 |
| 1978 | 4,149,288 | 182,442,540 | (85) | 32,294,536 | (15) | 0 | | 214,737,076 | 51.75 |
| 1979 | 11,218,434 | 219,928,232 | (71) | 89,300,703 | (29) | 0 | | 309,228,935 | 27.56 |
| 1980 | 17,505,268 | 150,421,026 | (62) | 76,244,773 | (38) | 0 | | 199,172,858 | 12.95 |
| 1981 | 1,754,358 | 6,549,125 | (15) | 37,595,987 | (85) | 0 | | 44,145,112 | 25.16 |
| 1982 | 1,134,840 | 51,893,988 | (96) | 1,937,408 | ( 4) | 2,065 | | 53,833,461 | 47.44 |
| 1983 | 3,569,982 | 23,590,443 | (31) | 53,260,693 | (69) | 123,975 | | 76,975,111 | 21.56 |
| 1984 | 10,490,670 | 83,470,460 | (20) | 331,384,545 | (80) | 43,135 | | 414,898,140 | 39.55 |
| 1985 | 7,211,046 | 11,178,398 | (11) | 87,004,194 | (89) | 30,345 | | 98,212,937 | 13.62 |
| 1986 | 1,179,322 | 13,126,363 | (66) | 6,830,717 | (34) | | | 19,957,080 | 16.92[b] |
| 1987 | 6,065,880 | 146,603,154 | | | | | | | |

[a] Percent of total smolt production

[b] Preliminary total

Table 5. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1952-1987 brood years, Kvichak River.

| Brood Year | Total Spawning Escapement | Age I | | | Age II | | |
|---|---|---|---|---|---|---|---|
| | | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt |
| | | Estimates of smolt numbers based upon fyke net catches | | | | | |
| 1952 | - | - | | | 241,870 | 3,610,258 | 14.93 |
| 1953 | - | 18,198 | 152,165 | 8.36 | 47,373 | 424,627 | 8.96 |
| 1954 | - | 30,287 | 109,965 | 3.63 | 8,654 | 659,246 | 76.18 |
| 1955 | - | 22,253 | 351,240 | 15.78 | 66,679 | 1,132,813 | 16.99 |
| 1956 | 9,443,318 | 3,267,274 | 31,253,977 | 9.57 | 2,777,960 | 7,773,131 | 2.80 |
| 1957 | 2,842,810 | 85,916 | 488,844 | 5.69 | 552,603 | 3,591,552 | 6.50 |
| 1958 | 534,785 | 61,400 | 124,250 | 2.02 | 10,126 | 161,253 | 15.92 |
| 1959 | 680,000 | 26,038 | 328,287 | 12.61 | 72,180 | 217,593 | 3.01 |
| 1960 | 14,630,000 | 1,130,820 | 1,877,221 | 1.66 | 4,116,093 | 53,360,190 | 12.96 |
| 1961 | 3,705,849 | 113,338 | 524,416 | 4.63 | 1,603,464 | 2,971,816 | 1.85 |
| 1962 | 2,580,884 | 458,122 | 256,253 | 0.56 | 1,748,178 | 5,083,162 | 2.91 |
| 1963 | 338,760 | 64,377 | 98,571 | 1.53 | 23,377 | 1,008,242 | 43.13 |
| 1964 | 957,120 | 252,384 | 2,647,042 | 10.49 | 222,528 | 3,093,042 | 13.90 |
| 1965 | 24,325,926 | 2,866,214 | 10,349,415 | 3.61 | 5,475,362 | 34,671,692 | 6.33 |
| 1966 | 3,775,184 | 648,321 | 1,594,186 | 2.46 | 541,017 | 4,657,432 | 8.61 |
| 1967 | 3,216,208 | 594,327 | 621,690 | 1.05 | 298,282 | 900,307 | 3.02 |
| 1968 | 2,557,440 | 185,356 | 332,177 | 1.79 | - | | |
| | | Estimates of smolt numbers based upon sonar techniques | | | | | |
| 1968 | 2,557,440 | - | | | 5,959,383 | 209,105 | 0.04 |
| 1969 | 8,394,204 | 85,723,430 | 449,876 | 0.01 | 54,159,340 | 4,823,046 | 0.09 |
| 1970 | 13,935,306 | 464,219 | 56,805 | 0.12 | 191,842,930 | 15,350,282 | 0.08 |
| 1971 | 2,387,392 | 5,123,400 | 337,402 | 0.07 | 21,423,246 | 2,490,225 | 0.12 |
| 1972 | 1,009,962 | 2,740,610 | 436,664 | 0.16 | - | 1,504,342 | - |
| 1973 | 226,554 | - | 1,607,253 | - | 3,031,287 | 818,392 | 0.27 |
| 1974 | 4,433,844 | 108,356,892 | 8,353,688 | 0.08 | 114,269,848 | 17,797,272 | 0.16 |
| 1975 | 13,140,450 | 78,308,251 | 6,919,726 | 0.09 | 213,364,470 | 31,164,419 | 0.15 |
| 1976 | 1,965,282 | 32,226,544 | 6,132,602 | 0.19 | 26,423,348 | 4,431,287 | 0.17 |
| 1977 | 1,341,144 | 28,758,191 | 2,910,136 | 0.10 | 10,410,467 | 307,905 | 0.03 |
| 1978 | 4,149,288 | 182,442,540 | 2,989,871 | 0.02 | 32,294,536 | 2,169,833 | 0.07 |
| 1979 | 11,218,434 | 219,928,232 | 20,631,921 | 0.09 | 89,300,703 | 21,194,617 | 0.24 |
| 1980 | 22,505,268 | 150,421,026 | 4,536,972 | 0.03 | 76,244,773 | 8,527,417 | 0.11 |
| 1981 | 1,754,358 | 6,549,125 | 1,034,266 | 0.16 | 37,595,987 | 1,097,260 | 0.03 |
| 1982 | 1,134,840 | 51,893,988 | 991,104 | 0.02 | 1,937,408 | 662,863 | 0.34 |
| 1983 | 3,569,982 | 23,590,443 | 11,613,889 | 0.49 | 53,260,693 | 1,771,787 | 0.03 |
| 1984 | 10,490,670 | 83,470,460 | 4,476,802 | 0.05 | 331,384,545 | 19,490,377 | 0.06 |
| 1985 | 7,211,046 | 11,178,398 | 2,312,507 | 0.21 | 87,004,194 | 13,404,347 | 0.15[b] |
| 1986 | 1,179,322 | 13,126,363 | 693,391 | 0.05[b] | 6,830,717 | 0 | 0.00[b] |
| 1987 | 6,065,880 | 146,603,154 | 3,530 | 0.00 | | | |

[a] Includes estimates of returns through 1990.

[b] Future adult returns may increase these values.

Table 6. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Kvichak River, 1989.

| | Age I | | | | | Age II | | | | | Age III | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size |
| 5 28 | 85 | 9.5 | 5.6 | 2.09 | 59 | 91 | | 7.8 | | 1 | | | | | 0 |
| 5 29 | 85 | 10.1 | 5.8 | 2.37 | 90 | 107 | 12.6 | 10.6 | 4.48 | 10 | | | | | 0 |
| 5 30 | 87 | 11.1 | 5.9 | 3.37 | 50 | 111 | 9.1 | 10.8 | 2.27 | 9 | 105 | | 9.5 | | 1 |
| 5 31 | 85 | 8.1 | 6.5 | 2.39 | 18 | 107 | 1.2 | 10.8 | 2.56 | 2 | | | | | 0 |
| 6 01 | 85 | 7.2 | 5.8 | 1.77 | 39 | 110 | | 11.7 | | 1 | | | | | 0 |
| 6 02 | 86 | 10.2 | 5.2 | 1.89 | 40 | 109 | 7.2 | 12.7 | 2.29 | 20 | | | | | 0 |
| 6 03 | 84 | 11.7 | 5.4 | 2.34 | 95 | 111 | 10.7 | 12.4 | 3.38 | 16 | | | | | 0 |
| 6 04 | 84 | 10.9 | 5.3 | 2.07 | 79 | 117 | 1.2 | 11.2 | 1.31 | 2 | | | | | 0 |
| 6 05 | 83 | 7.2 | 5.0 | 1.40 | 37 | | | | | 0 | | | | | 0 |
| 6 06 | 85 | 10.1 | 5.4 | 2.44 | 86 | 110 | 3.0 | 11.1 | .42 | 2 | | | | | 0 |
| 6 07 | 87 | 7.0 | 5.4 | 1.08 | 20 | | | | | 0 | | | | | 0 |
| 6 08 | 85 | 11.1 | 5.7 | 3.04 | 102 | 109 | 5.6 | 12.0 | 1.67 | 9 | | | | | 0 |
| 6 09 | 84 | 11.6 | 5.1 | 2.10 | 105 | 112 | | 10.9 | | 1 | | | | | 0 |
| 6 10 | 84 | 12.1 | 5.2 | 2.11 | 87 | 107 | 10.1 | 10.4 | 2.41 | 7 | | | | | 0 |
| 6 11 | 84 | 15.1 | 5.4 | 2.83 | 69 | 103 | | 9.7 | | 1 | | | | | 0 |
| 6 12 | 83 | 13.2 | 5.3 | 2.43 | 60 | | | | | 0 | | | | | 0 |
| 6 15 | 84 | 10.3 | 5.7 | 2.14 | 69 | 109 | | 9.2 | | 1 | | | | | 0 |
| Totals | | | | | 1,105 | | | | | 82 | | | | | 1 |
| Means | 85 | | 5.5 | | | 108 | | 10.8 | | | 105 | | 9.5 | | |

[a] Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 7. Age composition of total migration, and mean fork length and weight by age class for sockeye salmon smolt, Kvichak River, 1955-1989.

| | Age I | | | Age II | | | Age III | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year of Migration | Percent of Total Estimate | Mean Length (mm) | Mean Weight (g) | Percent of Total Estimate | Mean Length (mm) | Mean Weight (g) | Percent of Total Estimate | Mean Length (mm) | Mean Weight (g) | Total Estimate | References |
| 1955[a] | 7 | 89 | - | 93 | - | - | 0 | - | - | 260,068 | Paulus and Parker (1974) |
| 1956 | 39 | 92 | - | 61 | 116 | - | 0 | - | - | 77,660 | " |
| 1957 | 72 | 96 | 7.3 | 28 | 120 | 14.4 | 0 | - | - | 30,907 | " |
| 1958 | 98 | 84 | 4.6 | 2 | 114 | - | 0 | - | - | 3,333,953 | " |
| 1959 | 3 | 80 | - | 97 | 99 | 7.6 | 0 | - | - | 2,863,876 | " |
| 1960 | 10 | 91 | 6.3 | 90 | 108 | 10.3 | 0 | - | - | 614,003 | " |
| 1961 | 72 | 92 | 6.8 | 28 | 117 | 13.1 | 0 | - | - | 36,164 | " |
| 1962 | 94 | 82 | 4.3 | 6 | 110 | 9.9 | 0 | - | - | 1,203,000 | " |
| 1963 | 3 | 83 | 4.8 | 97 | 98 | 7.5 | 0 | - | - | 4,229,431 | Marriott (1965) |
| 1964 | 22 | 87 | 5.2 | 78 | 108 | 9.8 | 0 | - | - | 2,061,586 | Pennoyer and Seibel (1965) |
| 1965 | 4 | 90 | 6.8 | 96 | 109 | 11.3 | 0 | - | - | 1,812,555 | Pennoyer (1966) |
| 1966 | 92 | 94 | 7.4 | 8 | 114 | 12.6 | 0 | - | - | 275,761 | Pennoyer and Stewart (1967) |
| 1967 | 93 | 86 | 5.9 | 7 | 118 | 14.2 | 0 | - | - | 3,088,742 | Pennoyer and Stewart (1969) |
| 1968 | 11 | 88 | 5.5 | 89 | 104 | 9.2 | 0 | - | - | 6,123,683 | Paulus and McCurdy (1969) |
| 1969 | 52 | 92 | 5.7 | 48 | 109 | 10.6 | 0 | - | - | 1,135,344 | McCurdy and Paulus (1972) |
| 1970 | 38 | 91 | 6.0 | 62 | 110 | 11.0 | 0 | - | - | 483,638 | Paulus and McCurdy (1972) |
| 1971 | 93 | 90 | 5.8 | 7 | 111 | 11.1 | 0 | - | - | 91,682,813 | Russell (1972) |
| 1972 | 1 | 80 | 4.2 | 99 | 106 | 10.0 | 0 | - | - | 54,623,559 | Parker (1974a) |
| 1973 | 3 | 86 | 5.1 | 97 | 97 | 8.3 | 0 | - | - | 196,966,331 | Parker (1974b) |
| 1974 | 9 | 96 | 8.3 | 79 | 111 | 13.1 | 12 | 124 | 17.5 | 27,082,626 | Krasnowski (1975) |
| 1975 | 63 | 98 | 8.4 | 37 | 122 | 16.4 | 0 | - | - | 15,632,531 | Randall (1976) |
| 1976 | 97 | 88 | 5.8 | 3 | 121 | 14.2 | 0 | - | - | 111,388,180 | Randall (1977) |
| 1977 | 38 | 86 | 5.5 | 62 | 106 | 10.1 | 0 | - | - | 192,578,099 | Randall (1978) |
| 1978 | 12 | 88 | 6.0 | 88 | 97 | 7.8 | 0 | - | - | 245,591,014 | Yuen (1980a) |
| 1979 | 51 | 90 | 6.0 | 49 | 109 | 10.3 | 0 | - | - | 55,181,540 | Yuen (1980b) |
| 1980 | 94 | 88 | 5.9 | 6 | 110 | 10.7 | 0 | - | - | 192,853,007 | Yuen and Wise (1982) |
| 1981 | 89 | 85 | 5.4 | 11 | 108 | 10.2 | 0 | - | - | 252,222,769 | Bergstrom and Yuen (1981) |
| 1982 | 58 | 84 | 5.1 | 39 | 103 | 9.1 | 0 | - | - | 239,721,729 | Bill (1984) |

-Continued-

Table 7. (p 2 of 2)

| Year of Migration | Age I Percent of Total Estimate | Age I Mean Length (mm) | Age I Mean Weight (g) | Age II Percent of Total Estimate | Age II Mean Length (mm) | Age II Mean Weight (g) | Age III Percent of Total Estimate | Age III Mean Length (mm) | Age III Mean Weight (g) | Total Estimate | References |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1983 | 8 | 80 | 4.9 | 92 | 98 | 8.5 | 0 | - | - | 82,793,899 | Bill et al. (1987) |
| 1984 | 58 | 90 | 6.8 | 42 | 104 | 10.0 | 0 | - | - | 89,489,975 | Bill (1986) |
| 1985 | 92 | 85 | 5.3 | 8 | 102 | 9.2 | 0 | - | - | 25,527,851 | Bill (1986) |
| 1986 | 61 | 84 | 5.5 | 39 | 107 | 10.4 | 0 | 102 | 9.1 | 136,733,218 | Bue et al. (1988) |
| 1987 | 3 | 82 | 4.5 | 97 | 96 | 7.0 | 0 | 97 | 8.5 | 342,686,918 | Cross et al. (1990) |
| 1988 | 13 | 86 | 5.6 | 87 | 99 | 8.3 | 0 | 107 | 9.8 | 100,173,692 | Woolington et al. (1990) |
| Mean | | 88 | 5.8 | | 108 | 10.5 | | 106 | 11.2 | | |
| 1989 | 95 | 85 | 5.5 | 5 | 108 | 10.8 | 0 | 107 | 9.8 | 153,464,216 | |

[a] Estimates of smolt numbers for 1955-1970 based on fyke net catches, estimates of smolt numbers for 1971-988 based on sonar techniques.

Table 8. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Kvichak River, 1989.

| | Estimated Age I | | | | Estimated Age II | | | |
|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Estimated Mean Weight (g) | Sample Size | Mean Length (mm) | Std. Error | Estimated Mean Weight (g) | Sample Size |
| 5 28[b] | 85 | 15.5 | 5.5 | 241 | 110 | | 11.6 | 1 |
| 5 29 | 85 | 20.2 | 5.5 | 516 | 109 | 9.9 | 11.5 | 10 |
| 5 30 | 86 | 16.8 | 5.7 | 269 | 112 | 16.9 | 12.2 | 38 |
| 5 31 | 84 | 11.3 | 5.4 | 86 | 104 | 3.0 | 10.0 | 4 |
| 6 01 | 83 | 11.3 | 5.2 | 71 | 104 | | 10.0 | 1 |
| 6 02 | 87 | 15.2 | 5.8 | 215 | 104 | 11.4 | 10.2 | 30 |
| 6 03 | 83 | 17.0 | 5.3 | 527 | 108 | 12.9 | 11.3 | 32 |
| 6 04 | 83 | 14.0 | 5.2 | 406 | 107 | 8.6 | 10.9 | 3 |
| 6 05 | 84 | 15.3 | 5.4 | 181 | 103 | 2.7 | 9.9 | 3 |
| 6 06 | 84 | 17.1 | 5.4 | 476 | 99 | | 8.9 | 1 |
| 6 07 | 86 | 9.6 | 5.6 | 100 | | | | |
| 6 08 | 85 | 20.1 | 5.5 | 572 | 110 | 13.8 | 11.9 | 17 |
| 6 09 | 84 | 17.1 | 5.3 | 544 | 105 | 4.2 | 10.5 | 2 |
| 6 10 | 84 | 18.1 | 5.3 | 462 | 104 | 7.3 | 10.1 | 7 |
| 6 11 | 83 | 21.5 | 5.2 | 448 | 111 | | 11.8 | 2 |
| 6 12 | 84 | 15.1 | 5.3 | 270 | 105 | 3.1 | 10.4 | 3 |
| 6 15 | 83 | 14.2 | 5.2 | 246 | 109 | 10.7 | 11.5 | 2 |
| Totals | | | | 5,630 | | | | 156 |
| Means | 84 | | 5.4 | | 106 | | 10.8 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

[b] Length-weight parameters by age group and discriminating length used to separate ages for May 28 through June 15 were:
age I a= - 9.13 b= 2.44 $r^2$= 0.55 n= 1,105
age II a= - 9.29 b= 2.50 $r^2$= 0.57 n= 82
discriminating length = 97.27

Table 9. Climatological and hydrological observations made at sockeye salmon smolt counting site, Kvichak River, 1989.

| Date | Cloud Cover[a] | | Wind Velocity (km/hr) | | Air Temp. (°C) | | Mean Water Temp. (°C)[b] | Precipitation (mm) | Water Clarity[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 0800 hours | 2000 hours | 0800 hours | 2000 hours | 0800 hours | 2000 hours | | | |
| 5 19 | 1 | 1 | 0-5 SW | 0-5 SW | - | - | 4.0 | 0.0 | clear |
| 5 20 | 2 | 4 | 0-5 SW | 0-5 SW | 7.0 | 10.0 | 3.5 | trace | clear |
| 5 21 | 4 | 2 | 15-20 SW | 10-15 SW | 7.0 | 7.0 | 3.0 | 0.4 | murky |
| 5 22 | 1 | 4 | 5-10 W | 5-10 SW | 2.5 | 7.0 | 3.0 | trace | clear |
| 5 23 | 4 | 3 | 0-5 W | 5-10 W | 3.5 | 5.0 | 3.0 | 0.2 | lt brown |
| 5 24 | 3 | 2 | 0-5 W | calm | 2.5 | 11.0 | 3.8 | 0.1 | clear |
| 5 25 | 3 | 4 | 0-5 W | calm | 3.5 | 7.0 | 3.8 | 0.1 | clear |
| 5 26 | 3 | 4 | 0-5 E | 20-25 E | 3.5 | 7.0 | 4.3 | 0.1 | clear |
| 5 27 | 4 | 3 | 25-45 E | 15-20 E | 3.0 | 9.0 | 4.0 | 0.1 | murky |
| 5 28 | 3 | 3 | 0-5 E | 0-5 E | 5.0 | 10.0 | 4.8 | 0.0 | murky |
| 5 29 | 3 | 4 | 5-10 E | 15-20 E | 5.5 | 10.0 | 5.0 | trace | murky |
| 5 30 | 3 | 3 | 0-5 E | 10-15 E | 7.0 | 10.0 | 5.0 | 0.1 | dk brown |
| 5 31 | 4 | 3 | 5-15 E | 10-15 E | 7.0 | 10.0 | 5.1 | trace | dk brown |
| 6 01 | 3 | 3 | calm | 10-15 E | 6.5 | 11.0 | 5.3 | trace | lt brown |
| 6 02 | 4 | 3 | 25-35 E | 25-30 E | 7.0 | 11.0 | 5.5 | trace | murky |
| 6 03 | 4 | 4 | 5-15 E | 10-15 E | 7.0 | 11.5 | 6.0 | trace | murky |
| 6 04 | 4 | 4 | 0-10 SW | 10-15 SW | 7.5 | 8.5 | 5.8 | 0.2 | murky |
| 6 05 | 4 | 4 | 5-10 SW | calm | 5.0 | 11.0 | 5.5 | trace | brown |
| 6 06 | 3 | 3 | calm | calm | 5.0 | 15.0 | 5.8 | trace | lt brown |
| 6 07 | 3 | 2 | calm | calm | 7.5 | 10.5 | 6.3 | 0.0 | clear |
| 6 08 | 3 | 4 | 0-5 SE | 25-30 E | 4.0 | 7.5 | 5.9 | trace | clear |
| 6 09 | 4 | 2 | 20-25 E | 20-25 E | 4.2 | 10.0 | 5.4 | 0.0 | murky |
| 6 10 | 3 | 4 | 0-5 E | 0-5 E | 5.0 | 9.0 | 5.8 | trace | clear |
| 6 11 | 2 | 1 | calm | 0-5 E | 5.0 | 14.0 | 6.9 | 0.1 | clear |
| 6 12 | 1 | 3 | calm | 0-5 E | 2.0 | 12.0 | 7.5 | 0.0 | murky |
| 6 13 | 3 | 3 | calm | calm | 7.0 | 13.0 | 7.8 | trace | clear |
| 6 14 | 3 | 3 | calm | 5-10 E | 5.0 | 13.0 | 7.8 | 0.0 | clear |
| 6 15 | 4 | 2 | calm | 5-10 E | 7.0 | 11.0 | 8.8 | 0.3 | lt brown |
| 6 16 | 3 | | 15-18 E | | 7.5 | | 8.5 | 0.0 | murky |

[a] 1 = cloud cover not more than 1/10
2 = cloud cover not more than 1/2
3 = cloud cover more than 1/2
4 = completely overcast
5 = fog

[b] mean of water temperature readings taken at 0400, 0800, 1200, 1600, and 2400 hours

[c] water clarity at 0800 hours

Table 10. Water temperatures at sockeye salmon smolt counting site, Kvichak River, 1963-1989.

| Year | Sample Period | Water Temperature (°C) Minimum | Maximum | Mean | References |
|---|---|---|---|---|---|
| 1963 | May 16 - Jun 14 | 2.2 | 8.9 | 5.5 | Marriott (1965) |
| 1964 | May 18 - Jun 14 | 0.0 | 5.6 | 2.6 | Pennoyer and Seibel (1965) |
| 1965 | May 17 - Jun 11 | 0.0 | 8.9 | 4.4 | Pennoyer (1966) |
| 1966 | May 16 - Jun 26 | 0.0 | 11.1 | 4.7 | Pennoyer and Stewart (1967) |
| 1967 | May 17 - Jun 20 | 1.1 | 9.4 | 6.9 | Pennoyer and Stewart (1969) |
| 1968 | May 12 - Jun 12 | 3.3 | 8.3 | 5.4 | Paulus and McCurdy (1969) |
| 1969 | May 16 - Jun 18 | 0.3 | 7.8 | 3.9 | McCurdy and Paulus (1972) |
| 1970 | May 13 - Jun 07 | 2.8 | 11.1 | 6.8 | Paulus and McCurdy (1972) |
| 1971 | May 17 - Jun 20 | 1.1 | 3.3 | 2.4 | Russell (1972) |
| 1972 | May 18 - Jun 18 | 0.6 | 5.0 | 2.9 | Parker (1974a) |
| 1973 | May 15 - Jun 14 | 2.9 | 8.9 | 4.9 | Parker (1974b) |
| 1974 | May 13 - Jun 09 | 3.0 | 8.0 | 6.2 | Krasnowski (1975) |
| 1975 | May 17 - Jun 15 | 2.0 | 8.0 | 3.8 | Randall (1976) |
| 1976 | May 18 - Jun 19 | 2.0 | 9.5 | 3.9 | Randall (1977) |
| 1977 | May 17 - Jun 14 | 3.0 | 9.5 | 6.4 | Randall (1978) |
| 1978 | May 19 - Jun 09 | 5.0 | 11.0 | 7.6 | Yuen (1980a) |
| 1979 | June 1 - Jun 10 | 8.0 | 10.0 | 8.6 | Yuen (1980b) |
| 1980 | May 16 - Jun 18 | 1.5 | 9.0 | 5.5 | Bergstrom and Yuen (1981) |
| 1981 | May 15 - Jun 09 | 7.0 | 10.0 | 8.2 | Yuen and Wise (1982) |
| 1982 | May 14 - Jun 15 | 2.5 | 8.5 | 4.9 | Bill (1984) |
| 1983 | May 19 - Jun 14 | 5.2 | 10.5 | 7.9 | Bill et al. (1987) |
| 1984 | May 19 - Jun 11 | 5.5 | 10.0 | 7.9 | Bill (1986) |
| 1985 | May 23 - Jun 20 | 2.0 | 7.0 | 4.6 | Bill (1986) |
| 1986 | May 18 - Jun 12 | 1.0 | 7.0 | 4.6 | Bue et al. (1988) |
| 1987 | May 21 - Jun 13 | 4.5 | 9.0 | 6.7 | Cross et al. (1990) |
| 1988 | May 17 - Jun 17 | 3.0 | 11.0 | 7.1 | Woolington et al. (1990) |
| | Mean | 3.0 | 8.7 | 5.6 | |
| 1989 | May 19 - Jun 16 | 3.0 | 8.8 | 5.8 | |

Table 11. Sonar counts recorded from three arrays each with 10 transducers at the sockeye salmon smolt counting site on the Egegik River, 1989.

| | Sonar Counts | | | |
|---|---|---|---|---|
| | Transducer Array | | | |
| Date[a] | Inshore | Center | Offshore | Total |
| 5 20 | 0 | 0 | 0 | 0 |
| 5 21 | 0 | 0 | 0 | 0 |
| 5 22 | 0 | 0 | 0 | 0 |
| 5 23 | 0 | 0 | 0 | 0 |
| 5 24 | 401 | 170 | 6 | 577 |
| 5 25 | 442,476 | 410,410 | 111,070 | 963,956 |
| 5 26 | 117,205 | 151,109 | 72,263 | 340,577 |
| 5 27 | 314,778 | 327,347 | 441,252 | 1,083,377 |
| 5 28 | 569,767 | 148,069 | 22,584 | 740,420 |
| 5 29 | 375,390 | 286,267 | 167,475 | 829,132 |
| 5 30 | 163,257 | 220,519 | 78,627 | 462,403 |
| 5 31 | 54,744 | 147,471 | 19,904 | 222,119 |
| 6 01 | 15,338 | 41,365 | 31,496 | 88,199 |
| 6 02 | 27,505 | 37,561 | 26,777 | 91,843 |
| 6 03 | 20,191 | 69,733 | 4,807 | 94,731 |
| 6 04 | 1,509 | 5,003 | 3,956 | 10,468 |
| 6 05 | 0 | 0 | 0 | 0 |
| 6 06 | 106 | 788 | 94 | 988 |
| 6 07 | 938 | 428 | 57 | 1,423 |
| 6 08 | 243 | 110 | 0 | 353 |
| 6 09 | 8,591 | 14,475 | 1,700 | 24,766 |
| Total | 2,112,439 | 1,860,825 | 982,068 | 4,955,332 |
| Percent | 42.63 | 37.55 | 19.82 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 12. Daily number of sockeye salmon smolt migrating seaward, estimated with hydroacoustic equipment, Egegik River, 1989.

| | Age I | | | Age II | | | Age III | | | All Ages | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 5 20 | 0 | 72.2 | 0 | 0 | 27.6 | 0 | 0 | 0.2 | 0 | 0 | 0 |
| 5 21 | 0 | 72.2 | 0 | 0 | 27.6 | 0 | 0 | 0.2 | 0 | 0 | 0 |
| 5 22 | 0 | 72.2 | 0 | 0 | 27.6 | 0 | 0 | 0.2 | 0 | 0 | 0 |
| 5 23 | 0 | 72.2 | 0 | 0 | 27.6 | 0 | 0 | 0.2 | 0 | 0 | 0 |
| 5 24 | 8,816 | 72.2 | 8,816 | 3,375 | 27.6 | 3,375 | 20 | 0.2 | 20 | 12,211 | 12,211 |
| 5 25 | 13,975,634 | 72.2 | 13,984,450 | 5,350,970 | 27.6 | 5,354,345 | 32,911 | 0.2 | 32,931 | 19,359,515 | 19,371,726 |
| 5 26 | 4,959,481 | 72.2 | 18,943,931 | 1,898,879 | 27.6 | 7,253,224 | 11,679 | 0.2 | 44,610 | 6,870,039 | 26,241,765 |
| 5 27 | 15,517,021 | 72.2 | 34,460,952 | 5,941,134 | 27.6 | 1,3194,358 | 36,540 | 0.2 | 81,150 | 21,494,695 | 47,736,460 |
| 5 28 | 11,499,937 | 70.8 | 45,960,889 | 4,749,797 | 29.2 | 17,944,155 | 0 | 0.0 | 81,150 | 16,249,734 | 63,986,194 |
| 5 29 | 11,743,180 | 70.8 | 57,704,069 | 4,850,263 | 29.2 | 22,794,418 | 0 | 0.0 | 81,150 | 16,593,443 | 80,579,637 |
| 5 30 | 5,718,352 | 67.7 | 63,422,421 | 2,733,247 | 32.3 | 25,527,665 | 0 | 0.0 | 81,150 | 8,451,599 | 89,031,236 |
| 5 31 | 3,415,927 | 78.5 | 66,838,348 | 935,018 | 21.5 | 26,462,683 | 0 | 0.0 | 81,150 | 4,350,945 | 93,382,181 |
| 6 01 | 1,541,029 | 85.8 | 68,379,377 | 256,089 | 14.3 | 26,718,772 | 0 | 0.0 | 81,150 | 1,797,118 | 95,179,299 |
| 6 02 | 1,621,221 | 84.0 | 70,000,598 | 308,574 | 16.0 | 27,027,346 | 0 | 0.0 | 81,150 | 1,929,795 | 97,109,094 |
| 6 03 | 1,802,252 | 88.5 | 71,802,850 | 234,881 | 11.5 | 27,262,227 | 0 | 0.0 | 81,150 | 2,037,133 | 99,146,227 |
| 6 04 | 162,096 | 88.5 | 71,964,946 | 21,125 | 11.5 | 27,283,352 | 0 | 0.0 | 81,150 | 183,221 | 99,329,448 |
| 6 05 | 0 | 88.5 | 71,964,946 | 0 | 11.5 | 27,283,352 | 0 | 0.0 | 81,150 | 0 | 99,329,448 |
| 6 06 | 15,309 | 88.5 | 71,980,255 | 1,995 | 11.5 | 27,285,347 | 0 | 0.0 | 81,150 | 17,304 | 99,346,752 |
| 6 07 | 29,880 | 88.5 | 72,010,135 | 3,894 | 11.5 | 27,289,241 | 0 | 0.0 | 81,150 | 33,774 | 99,380,526 |
| 6 08 | 7,403 | 88.5 | 72,017,538 | 964 | 11.5 | 27,290,205 | 0 | 0.0 | 81,150 | 8,367 | 99,388,893 |
| 6 09 | 440,486 | 88.5 | 72,458,024 | 57,407 | 11.5 | 27,347,612 | 0 | 0.0 | 81,150 | 497,893 | 99,886,786 |
| | 72,458,024 | 72.5 | | 27,347,612 | 27.4 | | 81,150 | .1 | | 99,886,786 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 13. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Egegik River, 1989.

| Date[a] | Mean Weight of Smolt (g) | Smolt per Count |
|---|---|---|
| 5 20 | 11.1 | 3.7 |
| 5 21 | 11.1 | 3.7 |
| 5 22 | 11.1 | 3.7 |
| 5 23 | 11.1 | 3.7 |
| 5 24 | 11.1 | 3.7 |
| 5 25 | 11.1 | 3.7 |
| 5 26 | 11.1 | 3.7 |
| 5 27 | 11.1 | 3.7 |
| 5 28 | 11.0 | 3.8 |
| 5 29 | 11.0 | 3.8 |
| 5 30 | 11.7 | 3.5 |
| 5 31 | 10.6 | 3.9 |
| 6 01 | 10.0 | 4.1 |
| 6 02 | 10.1 | 4.1 |
| 6 03 | 9.5 | 4.3 |
| 6 04 | 9.5 | 4.3 |
| 6 05 | 9.5 | 4.3 |
| 6 06 | 9.5 | 4.3 |
| 6 07 | 9.5 | 4.3 |
| 6 08 | 9.5 | 4.3 |
| 6 09 | 9.5 | 4.3 |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 14. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1978-1987 brood years, Egegik River.

| Brood Year | Total Spawning Escapement | Number of Smolt Produced | | | | |
|---|---|---|---|---|---|---|
| | | Age I (%)[a] | Age II (%)[a] | Age III | Total | Per Spawner |
| 1978 | 895,698 | - | - | 225,522 | - | - |
| 1979 | 1,032,042 | - | 14,287,075 | 0 | - | - |
| 1980 | 1,060,860 | 49,457,563 (75) | 16,524,563 (25) | 197,429 | 66,179,555 | 62.38 |
| 1981 | 694,680 | 2,242,326 ( 7) | 32,235,734 (93) | 52,852 | 34,530,912 | 49.71 |
| 1982 | 1,034,628 | 17,234,269 (60) | 11,434,848 (40) | 564 | 28,669,681 | 27.71 |
| 1983 | 792,282 | 54,585,828 (65) | 29,984,140 (35) | 85,087 | 84,655,055 | 106.84 |
| 1984 | 1,165,320 | 14,016,441 (24) | 45,386,536 (76) | 80,931 | 59,483,908 | 51.05 |
| 1985 | 1,095,204 | 4,397,087 (26) | 12,758,135 (74) | 81,150 | 17,236,372 | 15.74 |
| 1986 | 1,151,320 | 36,122,149 (57) | 27,347,612 (43) | | 63,469,761 | 55.13[b] |
| 1987 | 1,272,978 | 72,458,024 | | | | |

[a] Percent of total smolt production

[b] Preliminary, age-III outmigration in 1990 may increase this total.

Table 15. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1978-1986 brood years, Egegik River.

| Brood Year | Total Spawning Escapement | Age I | | | Age II | | | Age III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt |
| 1978 | 895,698 | - | 907,413 | | - | 8,310,922 | | 225,522 | 33,756 | 0.15 |
| 1979 | 1,032,042 | - | 1,246,161 | | 14,287,075 | 4,737,895 | 0.33 | 0 | 0 | 0.00 |
| 1980 | 1,060,860 | 49,457,563 | 3,027,613 | 0.06 | 16,524,563 | 5,502,662 | 0.33 | 197,429 | 7,888 | 0.04 |
| 1981 | 694,680 | 2,242,326 | 1,532,938 | 0.68 | 32,235,734 | 4,875,574 | 0.15 | 52,852 | 16,104 | 0.30 |
| 1982 | 1,034,628 | 17,234,269 | 2,901,187 | 0.17 | 11,434,848 | 3,442,382 | 0.30 | 564 | 12,655 | 22.44[b] |
| 1983 | 792,282 | 54,585,828 | 4,507,190 | 0.08 | 29,984,140 | 6,016,215 | 0.20[b] | 85,087 | 36,905 | 0.43[b] |
| 1984 | 1,165,320 | 14,016,441 | 1,572,383 | 0.11[b] | 45,386,536 | 11,341,791 | 0.25[b] | 80,931 | 210,246 | 2.60[b] |
| 1985 | 1,095,192 | 4,397,087 | 1,930,592 | 0.44[b] | 12,758,135 | 4,294,556 | 0.34[b] | 81,150 | 0 | 0.00[b] |
| 1986 | 1,151,320 | 36,122,149 | 1,847,679 | 0.05[b] | 27,347,612 | 10,211 | 0.00[b] | | | |
| 1987 | 1,272,978 | 72,458,024 | 0 | 0.00[b] | | | | | | |

[a] Includes estimates of returns through 1990.

[b] Future adult returns may increase these values.

Table 16. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Egegik River, 1989.

| | Age I | | | | | Age II | | | | | Age III | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size |
| 5 27 | 100 | 11.8 | 9.5 | 4.19 | 61 | 119 | 26.5 | 15.4 | 10.07 | 37 | 135 | | 21.1 | | 1 |
| 5 29 | 100 | 15.9 | 9.0 | 3.47 | 85 | 109 | 20.3 | 11.4 | 6.03 | 14 | | | | | 0 |
| 5 30 | 102 | 15.5 | 9.5 | 4.45 | 47 | 127 | 18.2 | 18.4 | 6.81 | 37 | | | | | 0 |
| 5 31 | 99 | 13.6 | 8.6 | 3.07 | 88 | 122 | 13.2 | 16.3 | 5.44 | 10 | | | | | 0 |
| 6 01 | 99 | 13.7 | 8.9 | 3.79 | 66 | 129 | 13.8 | 18.8 | 5.96 | 16 | | | | | 0 |
| 6 02 | 97 | 14.4 | 8.4 | 3.94 | 90 | 114 | | 13.4 | | 1 | | | | | 0 |
| 6 03 | 97 | 12.2 | 8.4 | 3.38 | 95 | 117 | 16.5 | 14.2 | 6.00 | 5 | | | | | 0 |
| Totals | | | | | 532 | | | | | 129 | | | | | 1 |
| Means | 99 | | 8.9 | | | 119 | | 15.4 | | | 135 | | 21.1 | | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 17. Mean fork length and weight of sockeye salmon smolt sampled from the Egegik River, 1939-1989.

| Year of Migration | Sample Dates | Sample Size | Age I | | Age II | | Age III | | References |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mean Length | Mean Weight | Mean Length | Mean Weight | Mean Length | Mean Weight | |
| 1939 | - | - | 96 | - | 105 | - | - | - | USF&WS (unpublished) |
| 1956 | - | 386 | 101 | - | 116 | - | 123 | - | " |
| 1957 | - | 236 | 107 | - | 120 | - | 130 | - | " |
| 1959 | - | 281 | 99 | - | 116 | - | 123 | - | " |
| 1960 | - | 159 | 106 | - | 115 | - | 140 | - | " |
| 1969 | - | 67 | 99 | - | 119 | - | 115 | - | Paulus (1972) |
| 1977 | May 27 - May 29 | 299 | 110 | 11.3 | 116 | 13.3 | - | - | ADF&G (unpublished) |
| 1978 | May 19 - May 22 | 319 | 104 | 10.1 | 122 | 15.4 | 130 | 18.1 | Huttunen (1980) |
| 1981 | May 15 - Jun 06 | 549 | 105 | 9.1 | 122 | 16.6 | 128 | 19.1 | Bue (1982) |
| 1982 | May 27 - Jun 15 | 881 | 104 | 9.2 | 130 | 17.1 | 145 | 23.5 | Bue (1984) |
| 1983[a] | May 17 - Jun 09 | 2,631 | 101 | 9.3 | 116 | 13.6 | - | - | Fried et al. (1987) |
| 1984[a] | May 10 - Jun 10 | 3,602 | 106 | 10.1 | 112 | 12.2 | 134 | 20.2 | Fried et al. (1986) |
| 1985[a] | May 24 - Jun 05 | 5,427 | 106 | 10.4 | 123 | 16.8 | 138 | 24.1 | Bue (1986) |
| 1986 | May 18 - Jun 11 | 1,120 | 101 | 9.0 | 122 | 15.7 | 140 | 22.6 | Bue et al. (1988) |
| 1987 | May 18 - Jun 13 | 1,953 | 107 | 11.6 | 114 | 14.1 | 128 | 18.9 | Cross et al. (1990) |
| 1988 | May 18 - Jun 13 | 1,595 | 103 | 10.2 | 117 | 14.3 | 136 | 21.2 | Woolington et al. (1990) |
| | Mean | | 103 | 10.0 | 118 | 14.9 | 132 | 21.0 | |
| 1989 | May 27 - Jun 06 | 661 | 99 | 8.9 | 119 | 15.4 | 135 | 21.1 | |

[a] Age, weight, and length samples pooled with estimated weight by age from length samples.

Table 18. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Egegik River, 1989.

| Date[a] | Estimated Age I | | | | Estimated Age II | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean Length (mm) | Std. Error | Estimated Mean Weight (g) | Sample Size | Mean Length (mm) | Std. Error | Estimated Mean Weight (g) | Sample Size |
| 5 27[b] | 101 | 16.2 | 9.2 | 402 | 121 | 32.3 | 16.0 | 135 |
| 5 29 | 100 | 16.1 | 9.1 | 341 | 122 | 32.0 | 16.1 | 186 |
| 5 30 | 100 | 16.6 | 8.9 | 328 | 125 | 31.3 | 17.2 | 163 |
| 5 31 | 101 | 15.4 | 9.1 | 398 | 122 | 30.7 | 16.4 | 132 |
| 6 01 | 100 | 16.5 | 9.0 | 429 | 120 | 25.5 | 15.6 | 64 |
| 6 02 | 100 | 17.3 | 8.9 | 411 | 125 | 28.7 | 17.2 | 90 |
| 6 03 | 99 | 17.8 | 8.9 | 484 | 118 | 24.0 | 15.0 | 67 |
| Totals | | | | 2793 | | | | 837 |
| Means | 100 | | 9.0 | | 122 | | 16.2 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

[b] Length-weight parameters by age group and discriminating length used to separate ages for May 27 through June 6 were:
age I a= - 8.73 b= 2.37 $r^2$= 0.72 n= 531
age II a= -10.38 b= 2.74 $r^2$= 0.83 n= 129
discriminating length = 108.76

Table 19. Climatological and hydrological observations made at sockeye salmon smolt counting site, Egegik River, 1989.

| Date | Cloud Cover[a] 0800 hours | Cloud Cover[a] 2000 hours | Wind Velocity (km/hr) 0800 hours | Wind Velocity (km/hr) 2000 hours | Air Temp. (°C) Min. | Air Temp. (°C) Max. | Water Temp. (°C) 0800 hours | Water Temp. (°C) 2000 hours | Precipitation (mm) | Water Clarity |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 21 | 3 | 4 | 15-20 NW | 10 NW | 2.8 | 5.6 | 3.0 | 4.0 | 0.0 | clear |
| 5 22 | 4 | 4 | 15 W | 10 W | 3.3 | 5.6 | 3.0 | 4.0 | 0.0 | clear |
| 5 23 | 4 | 3 | 10-15 NW | 10-15 W | 3.3 | 5.0 | 3.0 | 5.0 | 0.0 | clear |
| 5 24 | 1 | 3 | 0-5 W | 0-5 W | 4.4 | 10.0 | 3.0 | 5.0 | 0.0 | clear |
| 5 25 | 3 | 4 | 5-10 E | 10-15 E | 4.4 | 10.0 | 3.0 | 5.0 | - | clear |
| 5 26 | 4 | 4 | 20-25 E | 25-35 E | 4.4 | 5.6 | 3.0 | 4.0 | - | clear |
| 5 27 | 3 | 3 | 20-25 E | 25-30 E | 5.6 | 6.7 | 3.8 | 4.5 | - | clear |
| 5 28 | 4 | 3 | calm | 10-15 E | 4.4 | 8.3 | 3.2 | 5.5 | - | clear |
| 5 29 | 4 | 4 | 5 E | 5 E | 6.7 | 5.0 | 3.5 | 5.0 | 2.0 | clear |
| 5 30 | 3 | 4 | 5-10 E | 5-10 E | 5.6 | 7.8 | 3.8 | 5.1 | 0.5 | clear |
| 5 31 | 3 | 3 | calm | 0-5 E | 5.6 | 11.1 | 3.8 | 5.8 | - | clear |
| 6 01 | 3 | 3 | 10-15 ESE | 5-10 NE | 7.2 | 12.2 | 4.8 | 6.5 | - | clear |
| 6 02 | 3 | 4 | 5-10 NE | 5-10 E | 6.1 | 10.1 | 4.6 | 6.7 | 13.2 | clear |
| 6 03 | 4 | 4 | 5-10 E | 5-10 E | 6.7 | 6.1 | 4.5 | 6.8 | 0.5 | clear |
| 6 04 | 5 | 4 | 5-10 SE | 5 SE | 6.1 | 10.1 | 4.2 | 7.0 | 3.1 | clear |
| 6 05 | 3 | 4 | calm | 0-5 W | 7.8 | 9.4 | 5.5 | 7.0 | 0.5 | clear |
| 6 06 | 3 | 3 | 5 NW | calm | 6.7 | 15.6 | 5.0 | 11.0 | - | clear |
| 6 07 | 5 | 3 | 15 E | 20 E | 5.0 | 11.7 | 5.4 | 9.0 | - | clear |
| 6 08 | 3 | 4 | 15-20 E | 5-10 E | 6.7 | 8.3 | 5.8 | 5.2 | 1.5 | clear |
| 6 09 | 3 | 4 | 1-5 NE | 15-25 NE | 7.2 | 8.9 | 5.1 | 6.0 | 10.1 | clear |
| 6 10 | 3 | - | 1-5 NE | - | 7.8 | - | 5.4 | - | - | clear |

[a] 1 = cloud cover not more than 1/10
2 = cloud cover not more than 1/2
3 = cloud cover more than 1/2
4 = completely overcast
5 = fog

Table 20. Water temperatures at sockeye salmon smolt counting site, Egegik River, 1981-1989.

| Year | Sample Period | Water Temperature (°C) Minimum | Maximum | Mean | Reference |
|---|---|---|---|---|---|
| 1981 | May 15 - Jun 08 | 5.0 | 9.0 | 7.3 | Bue (1982) |
| 1982 | May 15 - Jun 16 | 0.0 | 5.0 | 2.9 | Bue (1984) |
| 1983 | May 18 - Jun 10 | 5.0 | 9.5 | 7.0 | Fried et al. (1987) |
| 1984 | May 17 - Jun 11 | 5.0 | 10.0 | 7.6 | Fried et al. (1986) |
| 1985 | May 17 - Jun 12 | 2.5 | 7.5 | 4.2 | Bue (1986) |
| 1986 | May 19 - Jun 12 | 2.2 | 7.5 | 7.2 | Bue et al. (1988) |
| 1987 | May 18 - Jun 13 | 3.9 | 11.0 | 6.6 | Cross et al. (1990) |
| 1988 | May 19 - Jun 14 | 3.0 | 10.1 | 6.4 | Woolington et al.(1990) |
| | Mean | 3.3 | 8.7 | 6.2 | |
| 1989 | May 21 - Jun 10 | 3.0 | 11.0 | 5.2 | |

Table 21. Sonar counts recorded from two arrays each with 10 transducers at the sockeye salmon smolt counting site on the Ugashik River, 1989.

| | Sonar Counts | | |
|---|---|---|---|
| | Transducer Array | | |
| Date[a] | Inshore | Offshore | Total |
| 5 22 | 1,530 | 2,834 | 4,364 |
| 5 23 | 46,731 | 22,325 | 69,056 |
| 5 24 | 133,977 | 172,051 | 306,028 |
| 5 25 | 1,225,907 | 1,687,185 | 2,913,092 |
| 5 26 | 370,541 | 820,701 | 1,191,242 |
| 5 27 | 7,085 | 40,233 | 47,318 |
| 5 28 | 115,195 | 1,383,334 | 1,498,529 |
| 5 29 | 66,395 | 470,009 | 536,404 |
| 5 30 | 32,216 | 149,666 | 181,882 |
| 5 31[b] | 473,404 | 2,046,790 | 2,520,194 |
| 6 01 | 245,935 | 650,831 | 896,766 |
| 6 02 | 202,006 | 346,432 | 548,438 |
| 6 03 | 519,566 | 1,342,582 | 1,862,148 |
| 6 04 | 28,670 | 258,994 | 287,664 |
| 6 05 | 22,647 | 112,444 | 135,091 |
| 6 06 | 20,362 | 174,499 | 194,861 |
| 6 07 | 41,863 | 455,576 | 497,439 |
| 6 08 | 2,898 | 25,104 | 28,002 |
| 6 09[b] | 43,041 | 122,897 | 165,938 |
| 6 10 | 127,622 | 448,145 | 575,767 |
| 6 11[b] | 21,866 | 219,344 | 241,210 |
| 6 12 | 25,022 | 72,396 | 97,418 |
| 6 13 | 15,166 | 99,749 | 114,915 |
| 6 14 | 34,760 | 235,581 | 270,341 |
| 6 15 | 33,543 | 123,792 | 157,335 |
| Total | 3,857,948 | 11,483,494 | 15,341,442 |
| Percent | 25.2 | 74.8 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

[b] Interpolated data for hours 2000 on May 31, 0400-1500 on June 8, and 0600-1100 on June 11.

Table 22. Daily number of sockeye salmon smolt migrating seaward, estimated with hydroacoustic equipment, Ugashik River, 1989.

| | Age I | | | Age II | | | All Ages | |
|---|---|---|---|---|---|---|---|---|
| Date[a] | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 5 22 | 30,362 | 83.0 | 30,362 | 6,214 | 17.0 | 6,214 | 36,576 | 36,576 |
| 5 23 | 458,028 | 83.0 | 488,390 | 93,746 | 17.0 | 99,960 | 551,774 | 588,350 |
| 5 24 | 2,104,349 | 82.2 | 2,592,739 | 456,309 | 17.8 | 556,269 | 2,560,658 | 3,149,008 |
| 5 25 | 13,292,963 | 61.9 | 15,885,702 | 8,175,000 | 38.1 | 8,731,269 | 21,467,963 | 24,616,971 |
| 5 26 | 6,732,802 | 70.5 | 22,618,504 | 2,821,337 | 29.5 | 11,552,606 | 9,554,139 | 34,171,110 |
| 5 27 | 275,552 | 70.5 | 22,894,056 | 115,468 | 29.5 | 11,668,074 | 391,020 | 34,562,130 |
| 5 28 | 8,752,087 | 70.5 | 31,646,143 | 3,667,506 | 29.5 | 15,335,580 | 12,419,593 | 46,981,723 |
| 5 29 | 1,516,699 | 40.4 | 33,162,842 | 2,233,794 | 59.6 | 17,569,374 | 3,750,493 | 50,732,216 |
| 5 30 | 1,089,762 | 71.8 | 34,252,604 | 428,012 | 28.2 | 17,997,386 | 1,517,774 | 52,249,990 |
| 5 31 | 17,153,350 | 76.7 | 51,061,134 | 5,225,585 | 23.3 | 23,219,971 | 22,376,115 | 74,626,105 |
| 6 01 | 5,479,346 | 73.7 | 56,885,480 | 1,951,283 | 26.3 | 25,171,254 | 7,430,629 | 82,056,734 |
| 6 02 | 2,947,929 | 69.5 | 59,833,409 | 1,294,916 | 30.5 | 26,466,170 | 4,242,845 | 86,299,579 |
| 6 03 | 14,460,751 | 88.3 | 74,294,160 | 1,921,656 | 11.7 | 28,387,826 | 16,382,407 | 102,681,986 |
| 6 04 | 1,382,833 | 65.0 | 75,676,993 | 744,275 | 35.0 | 29,132,101 | 2,127,108 | 104,809,094 |
| 6 05 | 852,026 | 77.4 | 76,529,019 | 248,072 | 22.5 | 29,801,173 | 1,100,098 | 105,909,192 |
| 6 06 | 1,224,763 | 77.4 | 77,753,782 | 356,596 | 22.6 | 29,736,769 | 1,581,359 | 107,490,551 |
| 6 07 | 3,073,040 | 78.5 | 80,826,822 | 841,660 | 21.5 | 30,578,429 | 3,914,700 | 111,405,251 |
| 6 08 | 238,327 | 93.2 | 81,065,149 | 17,306 | 6.8 | 30,595,735 | 255,633 | 111,660,884 |
| 6 09 | 1,407,370 | 93.2 | 82,472,519 | 102,197 | 6.8 | 30,697,932 | 1,509,567 | 113,170,451 |
| 6 10 | 4,864,174 | 93.2 | 87,336,693 | 353,217 | 6.8 | 31,051,149 | 5,217,391 | 118,387,842 |
| 6 11 | 1,371,207 | 74.7 | 88,707,900 | 463,429 | 25.3 | 31,514,578 | 1,834,636 | 120,222,478 |
| 6 12 | 841,938 | 88.4 | 89,549,838 | 110,157 | 11.6 | 31,624,735 | 952,095 | 121,174,573 |
| 6 13 | 880,611 | 83.3 | 90,430,449 | 176,037 | 16.7 | 31,800,772 | 1,056,648 | 122,231,221 |
| 6 14 | 1,984,841 | 82.3 | 92,415,290 | 427,166 | 17.7 | 32,227,938 | 2,412,007 | 124,643,228 |
| 6 15 | 1,604,089 | 96.9 | 94,019,379 | 50,805 | 3.1 | 32,278,743 | 1,654,894 | 126,298,122 |
| | 94,019,379 | 74.0 | | 32,278,743 | 25.6 | | 126,298,122 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 23. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Ugashik River, 1989.

| Date[a] | Mean Weight of Smolt (g) | Smolt per Count |
|---|---|---|
| 5 22 | 7.7 | 5.4 |
| 5 23 | 7.7 | 5.4 |
| 5 24 | 7.5 | 5.6 |
| 5 25 | 8.5 | 4.9 |
| 5 26 | 7.9 | 5.2 |
| 5 27 | 7.9 | 5.2 |
| 5 28 | 7.9 | 5.2 |
| 5 29 | 9.3 | 4.4 |
| 5 30 | 7.8 | 5.3 |
| 5 31 | 7.3 | 5.7 |
| 6 01 | 7.7 | 5.4 |
| 6 02 | 7.5 | 5.5 |
| 6 03 | 6.6 | 6.3 |
| 6 04 | 7.9 | 5.3 |
| 6 05 | 7.1 | 5.8 |
| 6 06 | 7.1 | 5.8 |
| 6 07 | 7.4 | 5.6 |
| 6 08 | 6.4 | 6.5 |
| 6 09 | 6.4 | 6.5 |
| 6 10 | 6.4 | 6.5 |
| 6 11 | 7.6 | 5.5 |
| 6 12 | 6.6 | 6.2 |
| 6 13 | 7.1 | 5.8 |
| 6 14 | 7.4 | 5.6 |
| 6 15 | 6.2 | 6.7 |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 24. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1979-1987 brood years, Ugashik River.

| Brood Year | Total Spawning Escapement | Number of Smolt Produced | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Age I | (%)[a] | Age II | (%)[a] | Age III | Total | Per Spawner |
| 1979 | 1,700,904 | - | | - | | 0 | - | |
| 1980 | 3,321,384 | - | | 12,736,379 | | 26,384 | - | |
| 1981 | 1,326,762 | 31,297,432 | (27) | 82,656,993 | (73) | 0 | 113,954,425 | 85.89 |
| 1982 | 1,157,526 | 75,491,249 | (78) | 21,407,762 | (22) | 0 | 96,899,011 | 83.71 |
| 1983 | 1,000,614 | 12,693,628 | (46) | 15,186,101 | (54) | 1,677 | 27,881,406 | 27.86 |
| 1984 | 1,241,418 | 37,890,152 | (64) | 21,483,727 | (36) | 9,598 | 59,383,477 | 47.84 |
| 1985 | 998,232 | 5,461,821 | (14) | 33,238,739 | (86) | 0 | 38,700,560 | 38.77 |
| 1986 | 1,001,493 | 182,719,678 | (85) | 32,278,743 | (15) | | 214,998,421 | 214.68[b] |
| 1987 | 668,964 | 94,119,379 | | | | | | |

[a] Percent of total smolt production

[b] Preliminary, age-III outmigration in 1990 may increase this total.

Table 25. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1987 brood years, Ugashik River.

| Brood Year | Total Spawning Escapement | Age I | | | Age II | | | Age III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt |
| 1979 | 1,700,904 | - | 3,963,182 | | - | 2,004,153 | | 0 | 0 | |
| 1980 | 3,321,384 | - | 3,463,594 | | 12,736,379 | 4,193,843 | 0.33 | 26,384 | 2,627 | 0.10 |
| 1981 | 1,326,762 | 31,297,432 | 4,171,203 | 0.13 | 82,656,993 | 3,173,571 | 0.04 | 0 | 1,679 | 0.00 |
| 1982 | 1,157,526 | 75,491,249 | 1,132,268 | 0.02 | 21,407,762 | 1,338,487 | 0.06 | 0 | 0 | 0.00[b] |
| 1983 | 1,000,614 | 12,693,628 | 987,416 | 0.08 | 15,186,101 | 958,251 | 0.06[b] | 1,677 | 970 | 0.58[b] |
| 1984 | 1,241,418 | 37,890,152 | 1,051,938 | 0.03[b] | 21,483,727 | 4,397,856 | 0.20[b] | 9,598 | 1,491 | 0.16[b] |
| 1985 | 998,232 | 5,461,821 | 1,221,160 | 0.22[b] | 33,238,739 | 969,828 | 0.03[b] | 0 | 0 | 0.00[b] |
| 1986 | 1,001,493 | 182,719,678 | 502,225 | 0.00[b] | 32,278,743 | 745 | 0.00[b] | | | |
| 1987 | 668,964 | 94,019,379 | 493 | 0.00[b] | | | | | | |

[a] Includes estimates of returns through 1989.

[b] Future adult returns may increase these values.

Table 26. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Ugashik River, 1989.

| | Age I | | | | | Age II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size |
| 5 23 | 92 | 12.3 | 7.2 | 2.78 | 89 | 109 | 11.8 | 11.3 | 3.42 | 11 |
| 5 24 | 91 | 9.8 | 6.7 | 2.34 | 78 | 110 | 10.6 | 11.0 | 3.03 | 22 |
| 5 25 | 92 | 12.2 | 7.1 | 2.60 | 46 | 110 | 9.1 | 11.1 | 3.06 | 54 |
| 5 28 | 93 | 9.8 | 7.0 | 2.72 | 57 | 109 | 10.2 | 10.8 | 2.63 | 43 |
| 5 29 | 91 | 12.0 | 6.4 | 2.83 | 41 | 110 | 17.1 | 11.0 | 5.20 | 59 |
| 5 30 | 90 | 14.4 | 6.4 | 3.42 | 64 | 107 | 17.0 | 10.6 | 4.36 | 36 |
| 5 31 | 88 | 15.1 | 5.7 | 3.62 | 56 | 108 | 12.9 | 9.8 | 3.39 | 44 |
| 6 01 | 99 | 31.7 | 8.6 | 6.70 | 71 | 106 | 8.7 | 10.2 | 2.00 | 29 |
| 6 02 | 87 | 12.1 | 6.4 | 2.35 | 62 | 105 | 11.9 | 9.4 | 3.00 | 38 |
| 6 03 | 86 | 10.2 | 5.8 | 2.24 | 78 | 107 | 8.3 | 10.2 | 2.27 | 21 |
| 6 04 | 90 | 10.5 | 6.2 | 2.58 | 44 | 109 | 15.8 | 10.9 | 4.80 | 56 |
| 6 06 | 87 | 11.0 | 6.1 | 2.78 | 79 | 106 | 15.6 | 10.1 | 3.57 | 21 |
| 6 07 | 93 | 12.6 | 7.1 | 3.31 | 53 | 108 | 15.5 | 10.8 | 4.17 | 47 |
| 6 09 | 89 | 7.2 | 6.0 | 1.46 | 42 | 103 | 9.0 | 9.5 | 2.55 | 8 |
| 6 10 | 87 | 9.9 | 5.8 | 2.39 | 96 | 101 | 5.6 | 8.8 | 2.22 | 4 |
| 6 11 | 89 | 14.8 | 6.3 | 3.20 | 67 | 111 | 20.2 | 11.6 | 6.35 | 33 |
| 6 12 | 87 | 11.0 | 6.1 | 2.71 | 78 | 111 | 16.6 | 13.1 | 6.79 | 21 |
| 6 13 | 87 | 8.0 | 6.2 | 2.49 | 64 | 112 | 20.9 | 12.5 | 6.24 | 36 |
| 6 14 | 88 | 10.9 | 6.4 | 2.83 | 85 | 110 | 19.0 | 12.3 | 6.62 | 15 |
| 6 15 | 86 | 5.8 | 6.1 | 1.79 | 50 | | | | | 0 |
| Totals | | | | | 1,300 | | | | | 598 |
| Means | 90 | | 6.5 | | | 108 | | 10.7 | | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 27. Mean fork length and weight of sockeye salmon smolt sampled from the Ugashik River, 1958-1989.

| Year of Migration | Sample Dates | Sample Size | Age I | | Age II | | Age III | | References |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mean Length | Mean Weight | Mean Length | Mean Weight | Mean Length | Mean Weight | |
| 1958 | - | - | 93 | 6.4 | 112 | 11.7 | - | - | Pella and Jaenicke (1978) |
| 1959 | - | - | 90 | 6.1 | 120 | 13.5 | - | - | " |
| 1960 | - | - | 90 | 6.6 | 104 | 11.0 | - | - | " |
| 1961 | - | - | 90 | 6.7 | 112 | 12.2 | - | - | " |
| 1962 | May 12 - Jun 28 | 1,070 | 88 | 6.1 | 112 | 12.3 | - | - | Jaenicke (1963) |
| 1963 | May 05 _ Jun 26 | 921 | 90 | 6.1 | 104 | 9.6 | - | - | Nelson and Jaenicke (1965) |
| 1964 | May 15 - Jun 20 | 4,042 | 92 | 6.9 | 118 | 12.7 | - | - | Nelson (1965a) |
| 1965 | May 13 - Jun 20 | 3,296 | 94 | 6.9 | 114 | 12.5 | - | - | Nelson (1966a) |
| 1967 | May 15 - Jun 12 | 966 | 88 | 6.0 | 113 | 12.2 | - | - | Nelson (1969) |
| 1968 | May 13 - Jun 24 | 6,727 | 93 | 6.5 | 113 | 10.7 | - | - | Siedelman (1969) |
| 1969 | May 23 - Jun 06 | 567 | 97 | 7.5 | 121 | 14.5 | - | - | Schroeder (1972a) |
| 1970 | May 15 - Jun 10 | 907 | 97 | 7.7 | 125 | 15.9 | - | - | Schroeder (1972b) |
| 1972 | May 28 - Jun 20 | 615 | 81 | 5.0 | 112 | 11.2 | 129 | 14.3 | Schroeder (1974a) |
| 1973 | May 17 - Jun 12 | 1,189 | 93 | 7.2 | 113 | 11.9 | 132 | 20.1 | Schroeder (1974b) |
| 1974 | May 17 - Jun 17 | 355 | 94 | 7.4 | 119 | 13.6 | - | - | Schroeder (1975) |
| 1975 | Jun 03 - Jun 13 | - | 96 | 7.2 | 116 | 13.0 | 125 | 16.7 | Sanders (1976) |
| 1982 | Jun 06 - Jun 08 | 512 | 88 | 6.3 | 113 | 13.0 | 138 | 22.5 | Eggers (1984) |
| 1983 | May 21 - Jun 16 | 9,502 | 89 | 7.6 | 111 | 13.2 | - | - | Fried et al. (1987) |
| 1984 | May 23 - Jun 16 | 4,810 | 87 | 6.8 | 102 | 10.3 | 103 | 11.7 | Fried et al. (1986) |
| 1985 | May 22 - Jun 17 | 3,473 | 94 | 8.3 | 107 | 11.8 | - | - | Bue (1986) |
| 1986 | May 21 - Jun 14 | 1,555 | 87 | 5.8 | 114 | 10.9 | - | - | Bue et al. (1988) |
| 1987 | May 18 - Jun 12 | 2,190 | 94 | 7.9 | 107 | 11.1 | 138 | 24.1 | Cross et al (1990) |
| 1988 | May 17 - Jun 14 | 2,581 | 87 | 5.7 | 109 | 10.8 | 128 | 15.6 | Woolington et al. (1990) |
| | | Mean | 91 | 6.5 | 113 | 12.2 | 128 | 17.9 | |
| 1989 | May 23 - Jun 15 | 1,898 | 90 | 6.5 | 108 | 10.7 | - | - | |

Table 28. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Ugashik River, 1989.

| Date[a] | Estimated Age I | | | | Estimated Age II | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean Length (mm) | Std. Error | Estimated Mean Weight (g) | Sample Size | Mean Length (mm) | Std. Error | Estimated Mean Weight (g) | Sample Size |
| 5 23[b] | 92 | 18.3 | 6.9 | 475 | 110 | 13.7 | 11.1 | 117 |
| 5 24 | 91 | 17.1 | 6.7 | 503 | 110 | 13.3 | 11.1 | 120 |
| 5 25 | 93 | 12.4 | 7.0 | 320 | 110 | 15.4 | 11.0 | 228 |
| 5 28 | 91 | 16.6 | 6.6 | 360 | 109 | 13.9 | 10.8 | 159 |
| 5 29 | 91 | 19.8 | 6.7 | 165 | 110 | 18.2 | 11.1 | 383 |
| 5 30 | 91 | 20.7 | 6.7 | 391 | 108 | 14.1 | 10.6 | 177 |
| 5 31 | 89 | 19.4 | 6.4 | 412 | 107 | 12.1 | 10.4 | 122 |
| 6 01 | 89 | 20.4 | 6.4 | 384 | 108 | 16.4 | 10.6 | 160 |
| 6 02 | 88 | 21.4 | 6.1 | 366 | 108 | 17.4 | 10.5 | 190 |
| 6 03 | 86 | 15.3 | 5.8 | 294 | 107 | 9.9 | 10.5 | 35 |
| 6 04 | 89 | 18.9 | 6.3 | 351 | 108 | 15.1 | 10.5 | 212 |
| 6 06 | 87 | 21.3 | 6.0 | 412 | 107 | 15.7 | 10.4 | 146 |
| 6 07 | 89 | 19.8 | 6.3 | 418 | 108 | 14.4 | 10.5 | 103 |
| 6 09 | 87 | 10.1 | 6.0 | 44 | 105 | 3.9 | 9.7 | 7 |
| 6 10 | 88 | 17.1 | 6.0 | 497 | 107 | 10.9 | 10.4 | 31 |
| 6 11 | 87 | 18.4 | 5.9 | 392 | 113 | 25.0 | 12.1 | 149 |
| 6 12 | 87 | 19.1 | 5.9 | 469 | 107 | 16.0 | 10.5 | 57 |
| 6 13 | 89 | 16.6 | 6.2 | 468 | 109 | 18.2 | 11.0 | 85 |
| 6 14 | 88 | 15.3 | 6.1 | 431 | 114 | 23.8 | 12.5 | 110 |
| 6 15 | 86 | 11.4 | 5.8 | 264 | 109 | 8.5 | 10.8 | 9 |
| 6 16 | 86 | 10.2 | 5.8 | 99 | 110 | 1.8 | 11.1 | 2 |
| Totals | | | | 7,515 | | | | 2,602 |
| Means | 89 | | 6.3 | | 108 | | 10.8 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

[b] Length-weight parameters by age group and discriminating length used to separate ages for May 23 through June 16 were:
age I a= - 9.71 b= 2.57 $r^2$= 0.73 n= 1,300
age II a= - 10.36 b= 2.71 $r^2$= 0.77 n= 598
discriminating length = 101.09

Table 29. Climatological and hydrological observations made at sockeye salmon smolt counting site, Ugashik River, 1989.

| Date | Cloud Cover[a] 0800 hours | Cloud Cover[a] 2000 hours | Wind Velocity (km/hr) 0800 hours | Wind Velocity (km/hr) 2000 hours | Air Temp. (°C) Min. | Air Temp. (°C) Max. | Water Temp. (°C) 0800 hours | Water Temp. (°C) 2000 hours | Water Clarity |
|---|---|---|---|---|---|---|---|---|---|
| 5 21 | - | - | - | - | - | - | 4.0 | - | - |
| 5 22 | - | 2 | - | 10-20 S | - | 8.0 | 3.0 | 4.0 | clear |
| 5 23 | 4 | 4 | 15 W | 15 SW | 0.5 | 6.5 | 3.0 | 4.0 | clear |
| 5 24 | 4 | 1 | 10 SW | 0-5 SE | 0.0 | 6.5 | 3.0 | 4.5 | clear |
| 5 25 | 3 | 4 | - | 5-10 SE | 4.0 | 10.0 | 3.0 | 5.0 | clear |
| 5 26 | 3 | 4 | 10-15 SE | 40-50 SE | 5.0 | 15.0 | 4.5 | 5.0 | lt. brown |
| 5 27 | 3 | 3 | 30 SE | 50 gusts | 2.0 | 10.0 | 5.0 | 6.0 | murky |
| 5 28 | 5 | 1 | 2-5 NW | 15-20 SE | 4.0 | 10.0 | 4.0 | 7.0 | lt. brown |
| 5 29 | 3 | 4 | 5 SE | 7 SE | 4.0 | 9.0 | 6.0 | 7.0 | lt. brown |
| 5 30 | 2 | - | 10-15 SE | 5-8 SE | 5.0 | 10.0 | 6.0 | 6.8 | lt. brown |
| 5 31 | 3 | - | 2 SE | - | 5.0 | 10.0 | 6.0 | - | clear |
| 6 01 | 3 | 3 | 5 SE | 20-30 SE | 5.0 | 8.0 | 6.5 | 7.0 | clear |
| 6 02 | 4 | 4 | 15 SE | 10-15 SE | 5.0 | 8.0 | 6.0 | 6.0 | lt. brown |
| 6 03 | 3 | 3 | 8 SW | 0-5 SW | 5.5 | 8.0 | 5.8 | 7.0 | lt. brown |
| 6 04 | 3 | 4 | - | 0-5 W | 3.5 | 11.0 | 5.0 | 5.5 | lt. brown |
| 6 05 | 3 | 4 | 0-1 var. | 0-5 SE | 4.5 | 11.0 | 5.0 | 6.0 | clear |
| 6 06 | 3 | 2 | 3 SE | 10-20 SE | 4.5 | 9.5 | 4.8 | 6.0 | clear |
| 6 07 | 1 | 4 | - | 3 NE | 4.0 | 12.0 | 7.0 | 6.5 | lt. brown |
| 6 08 | 4 | 4 | 35-45 SE | 10-20 SE | 5.5 | 8.5 | 7.0 | 6.0 | dk. brown |
| 6 09 | 3 | 2 | 2 SE | 5-10 SE | 4.0 | 8.5 | 6.0 | 7.0 | lt. brown |
| 6 10 | 3 | 4 | 5 SE | 10-20 SE | 4.5 | 8.0 | 5.8 | 7.0 | clear |
| 6 11 | 2 | 1 | 5-10 SE | 0-5 SE | 5.0 | 16.0 | 7.0 | 8.8 | clear |
| 6 12 | 3 | 4 | 5 NW | 5-10 NW | 5.5 | 11.5 | 6.5 | 6.0 | clear |
| 6 13 | 4 | 4 | 2 NW | 5-10 NW | 5.0 | 18.0 | 5.5 | 6.0 | clear |
| 6 14 | 1 | 1 | 5 SE | 10-20 SW | 5.0 | 12.0 | 5.5 | 8.0 | clear |
| 6 15 | 2 | 2 | 5 SE | 5-10 SW | 5.0 | 13.0 | 7.0 | 8.5 | clear |
| 6 16 | 3 | - | 5-10 E | - | 7.0 | 17.0 | 8.0 | - | - |

[a] 1 = cloud cover not more than 1/10
2 = cloud cover not more than 1/2
3 = cloud cover more than 1/2
4 = completely overcast
5 = fog

Table 30. Water temperatures at sockeye salmon smolt counting site, Ugashik River, 1983-1989.

| Year | Sample Period | Water Temperature (°C) Minimum | Maximum | Mean | Reference |
|---|---|---|---|---|---|
| 1983 | May 23 - Jun 11 | 6.0 | 8.5 | 7.3 | Fried et al. (1987) |
| 1984 | May 20 - Jun 17 | 4.8 | 8.5 | 6.3 | Fried et al. (1986) |
| 1985 | May 17 - Jun 09 | -1.0 | 7.0 | 4.3 | Bue (1986) |
| 1986 | May 23 - Jun 28 | 2.0 | 7.0 | 5.6 | Bue et al. (1988) |
| 1987 | May 17 - Jun 13 | 4.0 | 9.0 | 5.9 | Cross et al. (1990) |
| 1988 | May 17 - Jun 13 | 3.5 | 10.0 | 6.6 | Woolington et al. (1990) |
| | Mean | 3.2 | 8.3 | 6.0 | |
| 1989 | May 21 - Jun 16 | 3.0 | 8.8 | 5.8 | |

Table 31. Sonar counts recorded from four arrays each with 10 transducers at the sockeye salmon smolt counting site on the Wood River, 1989.

| | Sonar Counts | | | | |
|---|---|---|---|---|---|
| | Transducer Array | | | | |
| Date[a] | I | II | III | IV | Total |
| 6 09 | 5,901 | 3,452 | 3,511 | 3,974 | 16,838 |
| 6 10 | 15,260 | 14,330 | 3,787 | 5,250 | 38,627 |
| 6 11 | 16,708 | 13,877 | 2,108 | 5,096 | 37,789 |
| 6 12 | 13,595 | 11,473 | 15,290 | 20,124 | 60,482 |
| 6 13 | 3,890 | 3,216 | 3,927 | 7,228 | 18,261 |
| 6 14 | 3,811 | 7,733 | 2,746 | 10,402 | 24,692 |
| 6 15 | 2,708 | 5,304 | 9,745 | 6,504 | 24,261 |
| 6 16 | 3,506 | 6,256 | 1,739 | 2,780 | 14,281 |
| 6 17 | 6,170 | 3,144 | 3,192 | 4,745 | 17,251 |
| 6 18 | 5,400 | 5,477 | 3,349 | 3,742 | 17,968 |
| 6 19 | 8,293 | 3,903 | 2,339 | 6,977 | 21,512 |
| 6 20 | 1,204 | 1,352 | 1,042 | 1,971 | 5,569 |
| 6 21 | 2,354 | 1,383 | 2,870 | 2,743 | 9,350 |
| 6 22 | 1,300 | 3,509 | 1,697 | 1,782 | 8,288 |
| 6 23 | 899 | 2,869 | 1,524 | 1,918 | 7,210 |
| 6 24 | 2,537 | 2,926 | 1,461 | 2,411 | 9,335 |
| 6 25 | 1,048 | 2,049 | 2,431 | 2,849 | 8,377 |
| 6 26 | 666 | 2,594 | 3,419 | 5,149 | 11,828 |
| 6 27 | 10,117 | 6,519 | 2,591 | 2,902 | 22,129 |
| 6 28 | 5,021 | 4,571 | 2,655 | 2,393 | 14,640 |
| 6 29 | 5,646 | 6,547 | 4,068 | 2,238 | 18,499 |
| 6 30 | 3,479 | 5,421 | 4,386 | 8,606 | 21,892 |
| 7 01 | 3,308 | 5,381 | 6,121 | 5,881 | 20,691 |
| 7 02 | 2,339 | 3,081 | 5,631 | 2,259 | 13,310 |
| 7 03 | 2,029 | 2,398 | 3,332 | 2,345 | 10,104 |
| 7 04 | 2,861 | 2,352 | 2,031 | 2,756 | 10,000 |
| 7 05 | 2,193 | 2,001 | 1,030 | 948 | 6,172 |
| 7 06 | 1,121 | 2,431 | 2,833 | 3,616 | 10,001 |
| 7 07 | 1,316 | 1,600 | 1,491 | 1,548 | 5,955 |
| 7 08 | 4,291 | 1,084 | 1,258 | 2,722 | 9,355 |
| 7 09 | 1,226 | 1,852 | 1,460 | 1,938 | 6,476 |
| 7 10 | 5,615 | 4,728 | 2,673 | 1,605 | 14,621 |
| 7 11 | 1,612 | 5,933 | 5,934 | 2,879 | 16,358 |
| 7 12 | 865 | 1,024 | 1,063 | 911 | 3,863 |
| 7 13 | 1,040 | 1,442 | 1,198 | 952 | 4,632 |

-Continued-

Table 31. (p 2 of 2).

| Date[a] | Sonar Counts | | | | |
|---|---|---|---|---|---|
| | Transducer Array | | | | |
| | I | II | III | IV | Total |
| 7 14 | 462 | ,652 | 1,648 | 545 | 3,307 |
| 7 15 | 1,617 | 1,664 | 737 | 444 | 4,462 |
| 7 16 | 2,615 | 2,567 | 1,615 | 1,590 | 8,387 |
| 7 17 | 3,414 | 3,769 | 2,988 | 2,012 | 12,183 |
| 7 18 | 997 | 1,361 | 1,422 | 1,800 | 5,580 |
| 7 19 | 2,332 | 2,939 | 2,945 | 5,878 | 14,094 |
| 7 20 | 5,219 | 4,655 | 2,828 | 1,777 | 14,479 |
| 7 21 | 1,574 | 1,957 | 4,489 | 3,536 | 11,556 |
| 7 22 | 755 | 2,404 | 2,469 | 2,592 | 8,220 |
| 7 23 | 3,557 | 3,025 | 2,994 | 3,483 | 13,059 |
| 7 24 | 2,343 | 3,818 | 4,044 | 2,509 | 12,714 |
| 7 25 | 1,532 | 1,472 | 1,678 | 1,164 | 5,846 |
| 7 26 | 1,566 | 3,436 | 4,242 | 2,591 | 11,835 |
| 7 27 | 4,537 | 4,407 | 4,968 | 3,511 | 17,423 |
| 7 28 | 876 | 2,586 | 2,259 | 3,925 | 9,646 |
| 7 29 | 1,610 | 3,613 | 2,296 | 2,229 | 9,748 |
| 7 30 | 1,899 | 6,213 | 3,782 | 2,562 | 14,456 |
| 7 31 | 1,525 | 2,608 | 3,733 | 3,145 | 11,011 |
| 8 01 | 1,306 | 3,010 | 4,118 | 5,539 | 13,973 |
| 8 02 | 2,175 | 6,089 | 4,472 | 4,439 | 17,175 |
| 8 03 | 3,516 | 19,463 | 2,244 | 6,937 | 42,160 |
| 8 04 | 1,885 | 2,923 | 3,312 | 2,929 | 11,049 |
| 8 05 | 2,627 | 5,193 | 3,777 | 1,855 | 13,452 |
| 8 06 | 1,964 | 7,677 | 4,340 | 4,112 | 18,093 |
| Total | 201,232 | 250,713 | 199,332 | 213,248 | 864,525 |
| Percent | 23.3 | 29.0 | 23.0 | 24.7 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 32. Percentage of total unexpanded sonar counts recorded over each array, Wood River, 1975-1989.

| | Percentage of Sonar Counts | | | | |
|---|---|---|---|---|---|
| | Transducer Array | | | | |
| Year | I | II | III | IV | References |
| 1975[a] | 68.6 | 31.4 | - | - | Krasnowski (1976) |
| 1976 | 49.0 | 30.2 | 11.7 | 9.1 | Krasnowski (1977) |
| 1977 | 36.0 | 24.4 | 20.8 | 18.8 | Newcome (1978) |
| 1978 | 28.6 | 29.7 | 25.6 | 16.1 | Clark and Robertson (1980) |
| 1979 | 17.0 | 27.1 | 33.1 | 22.8 | Bucher (1980) |
| 1980 | 34.1 | 35.2 | 20.5 | 10.2 | Bucher (1981) |
| 1981 | 39.2 | 24.8 | 24.9 | 11.1 | Bucher (1982) |
| 1982 | 38.2 | 31.3 | 15.9 | 14.6 | Bucher (1984) |
| 1983 | 31.6 | 29.9 | 23.5 | 15.0 | Bucher (1987) |
| 1984 | 23.9 | 36.7 | 22.2 | 17.2 | Bucher (1986) |
| 1985 | 34.2 | 36.3 | 18.5 | 11.0 | Bucher (1986) |
| 1986 | 34.2 | 36.3 | 18.5 | 11.0 | Bue et al. (1988) |
| 1987 | 30.9 | 32.3 | 20.8 | 16.0 | Cross et al. (1990) |
| 1988 | 18.0 | 35.1 | 26.5 | 20.5 | Woolington et al. (1990) |
| Mean[b] | 31.9 | 31.5 | 21.7 | 14.9 | |
| 1989 | 23.3 | 29.0 | 23.0 | 24.7 | |

[a] Only two transducer arrays used.

[b] Data for 1975 omitted.

Table 33. Velocity correction factors used at Wood River, 1989.

| Date | Array I | Array II | Array III | Array IV |
|---|---|---|---|---|
| Jun 09 | 1.00 | 1.15 | 1.05 | 1.05 |
| Jun 10 - Jun 16 | 2.00 | 2.21 | 2.07 | 2.07 |
| Jun 17 - Jun 20 | 2.00 | 2.25 | 2.08 | 2.08 |
| Jun 21 - Jun 25 | 2.00 | 1.79 | 2.00 | 1.79 |
| Jun 26 - Jun 30 | 2.00 | 1.60 | 1.90 | 1.70 |
| Jul 01 - Jul 05 | 2.00 | 1.68 | 1.68 | 2.21 |
| Jul 06 - Jul 10 | 2.00 | 2.11 | 2.00 | 2.33 |
| Jul 11 - Jul 15 | 2.00 | 2.22 | 1.78 | 2.00 |
| Jul 16 | 2.00 | 2.11 | 1.68 | 1.68 |
| Jul 17 - Jul 20 | 1.00 | 1.05 | 0.84 | 0.84 |
| Jul 21 - Jul 25 | 1.00 | 1.06 | 1.16 | 1.13 |
| Jul 26 - Jul 30 | 1.00 | 1.06 | 1.09 | 1.09 |
| Jul 31 - Aug 06 | 1.00 | 1.03 | 1.09 | 1.06 |

Table 34. Daily number of sockeye salmon smolt migrating seaward, estimated with hydroacoustic equipment, Wood River, 1989.

| | Age I | | | Age II | | | All Ages | |
|---|---|---|---|---|---|---|---|---|
| Date[a] | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 6 09 | 469,774 | 88.8 | 469,774 | 59,131 | 11.2 | 59,131 | 528,905 | 528,905 |
| 6 10 | 2,095,663 | 88.8 | 2,565,437 | 263,786 | 11.2 | 322,917 | 2,359,449 | 2,888,354 |
| 6 11 | 2,078,327 | 88.8 | 4,643,764 | 261,604 | 11.2 | 584,521 | 2,339,931 | 5,228,285 |
| 6 12 | 3,427,550 | 88.8 | 8,071,314 | 431,434 | 11.2 | 1,015,955 | 3,858,984 | 9,087,269 |
| 6 13 | 1,172,606 | 92.2 | 9,243,920 | 99,614 | 7.8 | 1,115,569 | 1,272,220 | 10,359,489 |
| 6 14 | 1,651,598 | 92.2 | 10,895,518 | 140,306 | 7.8 | 1,255,875 | 1,791,904 | 12,151,393 |
| 6 15 | 1,471,545 | 92.2 | 12,367,063 | 125,010 | 7.8 | 1,380,885 | 1,596,555 | 13,747,948 |
| 6 16 | 834,528 | 90.0 | 13,201,591 | 92,725 | 10.0 | 1,473,610 | 927,253 | 14,675,201 |
| 6 17 | 998,521 | 90.0 | 14,200,112 | 110,946 | 10.0 | 1,584,556 | 1,109,467 | 15,784,668 |
| 6 18 | 1,211,227 | 95.3 | 15,411,339 | 60,268 | 4.7 | 1,644,824 | 1,271,495 | 17,056,163 |
| 6 19 | 1,494,411 | 95.3 | 16,905,750 | 74,359 | 4.7 | 1,719,183 | 1,568,770 | 18,624,933 |
| 6 20 | 394,197 | 95.3 | 17,299,947 | 19,614 | 4.7 | 1,738,797 | 413,811 | 19,038,744 |
| 6 21 | 570,238 | 95.3 | 17,870,185 | 28,374 | 4.7 | 1,767,171 | 598,612 | 19,637,356 |
| 6 22 | 498,000 | 95.3 | 18,368,185 | 24,779 | 4.7 | 1,791,950 | 522,779 | 20,160,135 |
| 6 23 | 438,825 | 95.3 | 18,807,010 | 21,835 | 4.7 | 1,813,785 | 460,660 | 20,620,795 |
| 6 24 | 470,268 | 86.4 | 19,277,278 | 74,023 | 13.6 | 1,887,808 | 544,291 | 21,165,086 |
| 6 25 | 424,669 | 86.4 | 19,701,947 | 66,846 | 13.6 | 1,954,654 | 491,515 | 21,656,601 |
| 6 26 | 580,685 | 86.4 | 20,282,632 | 91,404 | 13.6 | 2,046,058 | 672,089 | 22,328,690 |
| 6 27 | 1,044,962 | 86.4 | 21,327,594 | 164,484 | 13.6 | 2,210,542 | 1,209,446 | 23,538,136 |
| 6 28 | 688,225 | 86.4 | 22,015,819 | 108,331 | 13.6 | 2,318,873 | 796,556 | 24,334,692 |
| 6 29 | 875,451 | 90.0 | 22,891,270 | 97,272 | 10.0 | 2,416,145 | 972,723 | 25,307,415 |
| 6 30 | 1,118,234 | 90.0 | 24,009,504 | 124,248 | 10.0 | 2,540,393 | 1,242,482 | 26,549,897 |
| 7 01 | 1,111,316 | 90.0 | 25,120,820 | 123,479 | 10.0 | 2,663,872 | 1,234,795 | 27,784,692 |
| 7 02 | 655,046 | 90.0 | 25,775,866 | 72,782 | 10.0 | 2,736,654 | 727,828 | 28,512,520 |
| 7 03 | 527,905 | 90.0 | 26,303,771 | 58,656 | 10.0 | 2,795,310 | 586,561 | 29,099,081 |
| 7 04 | 552,393 | 90.0 | 26,856,164 | 61,377 | 10.0 | 2,856,687 | 613,770 | 29,712,851 |
| 7 05 | 330,967 | 93.5 | 27,187,131 | 22,894 | 6.5 | 2,879,581 | 353,861 | 30,066,712 |
| 7 06 | 655,459 | 93.5 | 27,842,590 | 45,341 | 6.5 | 2,924,922 | 700,800 | 30,767,512 |
| 7 07 | 372,853 | 93.5 | 28,215,443 | 25,792 | 6.5 | 2,950,714 | 398,645 | 31,166,157 |
| 7 08 | 594,869 | 93.5 | 28,810,312 | 41,150 | 6.5 | 2,991,864 | 636,019 | 31,802,176 |
| 7 09 | 385,485 | 92.8 | 29,195,797 | 30,087 | 7.2 | 3,021,951 | 415,572 | 32,217,748 |
| 7 10 | 792,161 | 92.8 | 29,987,958 | 61,828 | 7.2 | 3,083,779 | 853,989 | 33,071,737 |
| 7 11 | 864,819 | 92.8 | 30,852,777 | 67,499 | 7.2 | 3,151,278 | 932,318 | 34,004,055 |
| 7 12 | 156,839 | 94.5 | 31,009,616 | 9,110 | 5.5 | 3,160,388 | 165,949 | 34,170,004 |
| 7 13 | 187,802 | 94.5 | 31,197,418 | 10,909 | 5.5 | 3,171,297 | 198,711 | 34,368,715 |
| 7 14 | 122,690 | 94.5 | 31,320,108 | 7,126 | 5.5 | 3,178,423 | 129,816 | 34,498,531 |
| 7 15 | 178,917 | 94.5 | 31,499,025 | 10,393 | 5.5 | 3,188,816 | 189,310 | 34,687,841 |
| 7 16 | 321,509 | 94.5 | 31,820,534 | 18,676 | 5.5 | 3,207,492 | 340,185 | 35,028,026 |
| 7 17 | 230,316 | 94.5 | 32,050,850 | 13,378 | 5.5 | 3,220,870 | 243,694 | 35,271,720 |
| 7 18 | 107,383 | 94.5 | 32,158,233 | 6,237 | 5.5 | 3,227,107 | 113,620 | 35,385,340 |
| 7 19 | 278,319 | 94.5 | 32,436,552 | 16,167 | 5.5 | 3,243,274 | 294,486 | 35,679,826 |
| 7 20 | 277,013 | 94.5 | 32,713,565 | 16,091 | 5.5 | 3,259,365 | 293,104 | 35,972,930 |
| 7 21 | 264,006 | 94.5 | 32,977,571 | 15,335 | 5.5 | 3,274,700 | 279,341 | 36,252,271 |
| 7 22 | 191,394 | 94.5 | 33,168,965 | 11,117 | 5.5 | 3,285,817 | 202,511 | 36,454,782 |
| 7 23 | 295,176 | 94.5 | 33,464,141 | 17,146 | 5.5 | 3,302,963 | 312,322 | 36,767,104 |
| 7 24 | 281,068 | 94.5 | 33,745,209 | 16,326 | 5.5 | 3,319,289 | 297,394 | 37,064,498 |
| 7 25 | 129,000 | 94.5 | 33,874,209 | 7,493 | 5.5 | 3,326,782 | 136,493 | 37,200,991 |
| 7 26 | 258,298 | 94.5 | 34,132,507 | 15,004 | 5.5 | 3,341,786 | 273,302 | 37,474,293 |
| 7 27 | 377,624 | 94.5 | 34,510,131 | 21,935 | 5.5 | 3,363,721 | 399,559 | 37,873,852 |
| 7 28 | 230,653 | 94.5 | 34,740,784 | 13,398 | 5.5 | 3,377,119 | 244,051 | 38,117,903 |
| 7 29 | 217,998 | 94.5 | 34,958,782 | 12,663 | 5.5 | 3,389,782 | 230,661 | 38,348,564 |

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Table 34. (p 2 of 2).

| Date[a] | Age I Number | Age I Percent | Age I Cumulative Total | Age II Number | Age II Percent | Age II Cumulative Total | All Ages Daily Total | All Ages Cumulative Total |
|---|---|---|---|---|---|---|---|---|
| 7 30 | 317,677 | 94.5 | 35,276,459 | 18,453 | 5.5 | 3,408,235 | 336,130 | 38,684,694 |
| 7 31 | 243,064 | 94.5 | 35,519,523 | 14,119 | 5.5 | 3,422,354 | 257,183 | 38,941,877 |
| 8 01 | 268,169 | 93.1 | 35,787,692 | 19,967 | 6.9 | 3,442,321 | 288,136 | 39,230,013 |
| 8 02 | 315,546 | 93.1 | 36,103,238 | 23,495 | 6.9 | 3,465,816 | 339,041 | 39,569,054 |
| 8 03 | 751,535 | 93.1 | 36,854,773 | 55,959 | 6.9 | 3,521,775 | 807,494 | 40,376,548 |
| 8 04 | 210,371 | 93.8 | 37,065,144 | 14,024 | 6.3 | 3,535,799 | 224,395 | 40,600,943 |
| 8 05 | 245,990 | 93.8 | 37,311,134 | 16,399 | 6.3 | 3,552,198 | 262,389 | 40,863,332 |
| 8 06 | 342,852 | 93.8 | 37,653,986 | 22,856 | 6.3 | 3,575,054 | 365,708 | 41,229,040 |
| | 37,653,986 | 91.3 | | 3,575,054 | 8.7 | | 41,229,040 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 35. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Wood River, 1989.

| Date[a] | Mean Weight of Smolt (g) | Smolt per Count | Date[a] | Mean Weight of Smolt (g) | Smolt per Count |
|---|---|---|---|---|---|
| 6 09 | 6.4 | 6.5 | 7 09 | 6.9 | 6.0 |
| 6 10 | 6.4 | 6.5 | 7 10 | 6.9 | 6.0 |
| 6 11 | 6.4 | 6.5 | 7 11 | 6.9 | 6.0 |
| 6 12 | 6.4 | 6.5 | 7 12 | 9.4 | 4.4 |
| 6 13 | 6.0 | 6.9 | 7 13 | 9.4 | 4.4 |
| 6 14 | 6.0 | 6.9 | 7 14 | 9.4 | 4.4 |
| 6 15 | 6.0 | 6.9 | 7 15 | 9.4 | 4.4 |
| 6 16 | 6.3 | 6.6 | 7 16 | 9.4 | 4.4 |
| 6 17 | 6.3 | 6.6 | 7 17 | 9.4 | 4.4 |
| 6 18 | 5.7 | 7.3 | 7 18 | 9.4 | 4.4 |
| 6 19 | 5.7 | 7.3 | 7 19 | 9.4 | 4.4 |
| 6 20 | 5.7 | 7.3 | 7 20 | 9.4 | 4.4 |
| 6 21 | 5.7 | 7.3 | 7 21 | 9.4 | 4.4 |
| 6 22 | 5.7 | 7.3 | 7 22 | 9.4 | 4.4 |
| 6 23 | 6.3 | 6.6 | 7 23 | 9.4 | 4.4 |
| 6 24 | 6.3 | 6.6 | 7 24 | 9.4 | 4.4 |
| 6 25 | 6.3 | 6.6 | 7 25 | 9.4 | 4.4 |
| 6 26 | 6.3 | 6.6 | 7 26 | 9.4 | 4.4 |
| 6 27 | 6.3 | 6.6 | 7 27 | 9.4 | 4.4 |
| 6 28 | 6.3 | 6.6 | 7 28 | 9.4 | 4.4 |
| 6 29 | 6.4 | 6.5 | 7 29 | 9.4 | 4.4 |
| 6 30 | 6.4 | 6.5 | 7 30 | 9.4 | 4.4 |
| 7 01 | 6.4 | 6.5 | 7 31 | 9.4 | 4.4 |
| 7 02 | 6.4 | 6.5 | 8 01 | 11.2 | 3.7 |
| 7 03 | 6.4 | 6.5 | 8 02 | 11.2 | 3.7 |
| 7 04 | 6.4 | 6.5 | 8 03 | 11.2 | 3.7 |
| 7 05 | 6.4 | 6.5 | 8 04 | 10.9 | 3.8 |
| 7 06 | 6.4 | 6.5 | 8 05 | 10.9 | 3.8 |
| 7 07 | 6.4 | 6.5 | 8 06 | 10.9 | 3.8 |
| 7 08 | 6.4 | 6.5 | | | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 36. Sockeye salmon spawning escapements, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1972-1987 brood years, Wood River.

| Brood Year | Total Spawning Escapement | Number of Smolt Produced | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Age I | (%)[a] | Age II | (%)[a] | Age III | Total | Per Spawner | |
| 1972 | 430,602 | - | | 5,900,000 | | 0 | - | - | |
| 1973 | 330,474 | 27,950,000 | (85) | 4,800,000 | (15) | 0 | 32,750,000 | 99.24 | |
| 1974 | 1,708,836 | 101,400,000 | (89) | 12,550,000 | (11) | 0 | 113,950,000 | 66.64 | |
| 1975 | 1,270,116 | 60,750,000 | (88) | 8,400,000 | (12) | 0 | 69,150,000 | 54.45 | |
| 1976 | 817,008 | 46,600,000 | (90) | 5,127,868 | (10) | 0 | 51,727,868 | 63.31 | |
| 1977 | 561,828 | 60,838,182 | (97) | 1,993,345 | ( 3) | 0 | 62,831,527 | 111.83 | |
| 1978 | 2,267,238 | 46,302,587 | (58) | 33,196,940 | (42) | 0 | 79,499,527 | 35.06 | |
| 1979 | 1,706,352 | 64,330,507 | (92) | 4,706,853 | ( 8) | 0 | 69,037,360 | 40.46 | |
| 1980 | 2,969,040 | 32,354,984 | (89) | 4,133,901 | (11) | 0 | 36,488,885 | 12.29 | |
| 1981 | 1,233,318 | 19,594,247 | (93) | 1,378,417 | ( 7) | 0 | 20,972,664 | 17.01 | |
| 1982 | 976,470 | 22,332,474 | (83) | 4,692,859 | (17) | 0 | 27,025,333 | 27.68 | |
| 1983 | 1,360,968 | 31,948,110 | (98) | 597,724 | ( 2) | 2,592 | 32,548,426 | 23.92 | |
| 1984 | 1,002,792 | 27,466,684 | (92) | 2,335,723 | ( 8) | 0 | 29,802,407 | 29.72 | |
| 1985 | 939,000 | 29,039,259 | (97) | 971,516 | ( 3) | | 30,010,775 | 31.96 | |
| 1986 | 818,652 | 39,828,021 | (92) | 3,575,054 | ( 8) | | 43,403,075 | 53.02[b] | |
| 1987 | 1,337,172 | 37,653,986 | | | | | | | |

[a] Percent of total smolt production

[b] Preliminary, age-III outmigration in 1990 might increase total

Table 37. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt), for 1972-1987 brood years, Wood River.

| Brood Year | Total Spawning Escapement | Age I | | | Age II | | |
|---|---|---|---|---|---|---|---|
| | | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt |
| 1972 | 430,602 | - | 1,430,065 | | 5,900,000 | 59,353 | 0.01 |
| 1973 | 330,474 | 27,950,000 | 1,364,992 | 0.05 | 4,800,000 | 118,476 | 0.02 |
| 1974 | 1,708,836 | 101,400,000 | 4,661,537 | 0.05 | 12,550,000 | 496,546 | 0.04 |
| 1975 | 1,270,116 | 60,750,000 | 3,617,378 | 0.06 | 8,400,000 | 1,141,143 | 0.14 |
| 1976 | 817,008 | 46,600,000 | 4,895,420 | 0.11 | 5,127,868 | 867,507 | 0.17 |
| 1977 | 561,828 | 60,838,182 | 3,399,952 | 0.06 | 1,993,345 | 116,606 | 0.06 |
| 1978 | 2,267,238 | 46,302,587 | 2,546,030 | 0.05 | 33,196,940 | 742,252 | 0.02 |
| 1979 | 1,706,352 | 64,330,507 | 4,497,413 | 0.07 | 4,706,853 | 46,750 | 0.01 |
| 1980 | 2,969,040 | 32,354,984 | 1,585,416 | 0.05 | 4,133,901 | 187,961 | 0.05 |
| 1981 | 1,233,318 | 19,594,247 | 1,815,951 | 0.09 | 1,378,417 | 179,333 | 0.13 |
| 1982 | 976,470 | 22,332,474 | 1,471,659 | 0.07 | 4,692,859 | 149,409 | 0.03 |
| 1983 | 1,360,968 | 31,948,110 | 3,098,001 | 0.10 | 597,724 | 90,606 | 0.15 |
| 1984 | 1,002,792 | 27,466,684 | 1,960,754 | 0.07 | 2,335,723 | 53,921 | 0.02 |
| 1985 | 939,000 | 29,039,259 | 2,560,969 | 0.09 | 971,516 | 29,554 | 0.03[b] |
| 1986 | 818,652 | 39,828,021 | 1,216,728 | 0.03[b] | 3,575,054 | 0 | 0.00[b] |
| 1987 | 1,337,172 | 37,653,986 | 0 | 0.00[b] | | | |

[a] Includes estimates of returns through 1990.

[b] Future adult returns may increase these values.

Table 38. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Wood River, 1989.

| | Age I | | | | | Age II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size |
| 6 10 | 79 | 2.7 | 5.5 | 0.89 | 6 | 108 | 3.6 | 10.0 | 0.48 | 2 |
| 6 11 | 84 | 19.5 | 6.0 | 4.10 | 111 | 100 | 16.0 | 8.7 | 3.06 | 9 |
| 6 12 | 85 | 18.2 | 6.1 | 3.93 | 94 | 110 | | 11.8 | | 1 |
| 6 13 | 87 | 12.8 | 6.1 | 2.29 | 7 | | | | | 0 |
| 6 14 | 82 | 15.1 | 5.4 | 2.74 | 98 | 103 | 5.9 | 8.9 | 1.54 | 3 |
| 6 15 | 83 | 18.2 | 5.6 | 3.55 | 116 | 101 | 9.6 | 8.8 | 1.88 | 4 |
| 6 16 | 82 | 17.3 | 5.6 | 3.16 | 120 | | | | | 0 |
| 6 17 | 87 | 19.7 | 6.3 | 4.34 | 114 | 103 | 13.5 | 9.4 | 2.34 | 6 |
| 6 18 | 82 | 5.2 | 4.4 | 0.99 | 4 | | | | | 0 |
| 6 19 | 89 | 13.5 | 6.2 | 2.64 | 29 | 102 | 3.0 | 10.3 | .00 | 2 |
| 6 20 | 86 | 12.7 | 6.3 | 2.84 | 9 | | | | | 0 |
| 6 21 | 85 | 15.4 | 5.6 | 3.30 | 58 | 91 | | 6.8 | | 1 |
| 6 22 | 86 | 17.2 | 5.4 | 3.83 | 60 | | | | | 0 |
| 6 23 | 81 | 11.3 | 4.7 | 1.75 | 48 | | | | | 0 |
| 6 24 | 85 | 18.1 | 6.0 | 3.70 | 83 | 91 | 9.7 | 7.1 | 2.44 | 3 |
| 6 25 | 82 | 7.9 | 4.8 | 1.59 | 4 | 94 | 9.5 | 8.3 | 2.38 | 2 |
| 6 26 | 83 | 1.8 | 4.9 | 0.36 | 2 | | | | | 0 |
| 6 27 | 83 | 17.2 | 5.4 | 3.02 | 98 | 81 | | 4.2 | | 1 |
| 6 28 | 92 | 12.2 | 8.0 | 3.14 | 13 | 101 | 16.2 | 10.7 | 3.69 | 3 |
| 6 29 | 83 | 11.7 | 6.2 | 3.21 | 119 | 83 | | 6.8 | | 1 |
| 6 30 | 81 | 6.2 | 5.5 | 1.94 | 9 | 93 | | 5.3 | | 1 |
| 7 04 | 87 | 16.1 | 7.1 | 4.18 | 115 | 91 | 8.3 | 7.7 | 1.91 | 5 |
| 7 05 | 87 | 14.0 | 6.4 | 2.78 | 119 | | | | | 0 |
| 7 07 | 84 | 5.6 | 5.8 | 0.29 | 4 | | | | | 0 |
| 7 08 | 87 | 10.8 | 6.7 | 2.93 | 115 | 88 | | 7.3 | | 1 |
| 7 09 | 87 | 4.3 | 5.9 | 0.95 | 5 | | | | | 0 |
| 7 10 | 89 | 9.8 | 7.2 | 2.48 | 119 | | | | | 0 |
| 7 11 | 90 | 12.1 | 7.9 | 3.56 | 73 | 97 | 11.6 | 9.7 | 3.45 | 3 |
| 7 12 | 91 | 10.9 | 7.4 | 2.74 | 11 | | | | | 0 |
| 7 14 | 87 | 2.5 | 6.0 | 0.39 | 4 | | | | | 0 |
| 7 17 | 104 | 11.5 | 10.5 | 3.40 | 6 | | | | | 0 |
| 7 18 | 95 | 6.8 | 8.2 | 1.75 | 6 | | | | | 0 |
| 7 19 | 98 | 0.6 | 8.7 | 0.24 | 2 | 105 | | 9.1 | | 1 |
| 7 21 | 99 | 5.7 | 10.7 | 1.52 | 8 | 105 | | 12.0 | | 1 |
| 7 22 | 94 | 4.8 | 9.4 | 1.13 | 2 | | | | | 0 |
| 7 23 | 97 | 2.9 | 8.7 | 2.43 | 7 | | | | | 0 |
| 7 24 | 100 | 6.8 | 10.0 | 1.14 | 8 | | | | | 0 |
| 7 29 | 101 | 9.3 | 10.4 | 1.33 | 6 | | | | | 0 |
| 7 30 | 103 | 13.5 | 12.2 | 4.65 | 113 | 105 | | 13.0 | | 1 |
| 7 31 | 103 | 17.1 | 13.4 | 7.22 | 91 | 104 | | 13.7 | | 1 |
| 8 01 | 102 | 15.6 | 12.5 | 5.49 | 37 | | | | | 0 |
| 8 02 | 105 | 19.4 | 13.4 | 6.55 | 108 | 115 | 12.7 | 10.7 | 0.72 | 3 |
| 8 03 | 103 | 16.6 | 12.3 | 6.43 | 98 | | | | | 0 |
| 8 04 | 103 | 12.7 | 12.4 | 4.38 | 87 | | | | | 0 |
| 8 05 | 102 | 13.3 | 11.9 | 5.37 | 92 | | | | | 0 |
| 8 06 | 103 | 13.7 | 12.5 | 4.68 | 90 | | | | | 0 |
| Totals | | | | | 2,528 | | | | | 55 |
| Means | 91 | | 7.8 | | | 98 | | 9.1 | | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 39. Age composition of total migration, and mean fork length and weight by age class, for sockeye salmon smolt, Wood River, 1951-1989.

| Year of Migration | Age I Percent of Total Estimate | Age I Mean Length (mm) | Age I Mean Weight (g) | Age II Percent of Total Estimate | Age II Mean Length (mm) | Age II Mean Weight (g) | Total Estimate | References |
|---|---|---|---|---|---|---|---|---|
| 1951[a] | 80.0 | 91 | - | 20.0 | - | - | - | Univ. Washington (unpub.) |
| 1952 | 99.0 | 87 | - | 1.0 | - | - | - | " |
| 1953 | 95.3 | 86 | - | 4.7 | 103 | - | - | " |
| 1954 | 95.8 | 87 | - | 4.2 | 107 | - | - | " |
| 1955 | 98.0 | 85 | - | 2.0 | 102 | - | - | " |
| 1956 | 78.4 | 82 | - | 21.6 | 95 | - | - | " |
| 1957 | 80.7 | 77 | - | 19.3 | 93 | - | - | " |
| 1958 | 65.0 | 82 | - | 35.0 | 102 | - | - | " |
| 1959 | 93.5 | 88 | - | 6.5 | 105 | - | - | " |
| 1960 | 99.4 | 88 | - | 0.6 | 114 | - | - | " |
| 1961 | 93.0 | 82 | - | 7.0 | 102 | - | - | Church (1963) |
| 1962 | 86.0 | 80 | - | 14.0 | 98 | - | - | Church and Nelson (1963) |
| 1963 | 84.3 | 83 | - | 15.7 | 102 | - | - | Nelson (1964) |
| 1964 | 98.8 | 84 | - | 1.2 | 104 | - | - | Nelson (1965b) |
| 1965 | 92.0 | 86 | - | 8.0 | 106 | - | - | Nelson (1966b) |
| 1966 | 94.3 | 77 | - | 5.7 | 101 | - | - | Siedelman (1967) |
| 1975[b] | 86.0 | 83 | - | 14.0 | 98 | - | 33,850,000 | Krasnowski (1976) |
| 1976 | 95.5 | 84 | - | 4.5 | 95 | - | 106,200,000 | Krasnowski (1977) |
| 1977 | 82.9 | 71 | 3.5 | 17.1 | 98 | 9.3 | 73,300,000 | Newcome (1978) |
| 1978 | 84.7 | 79 | - | 15.3 | 90 | - | 55,000,000 | Clark and Robertson (1980) |
| 1979 | 92.2 | 90 | 7.6 | 7.8 | 100 | 10.1 | 65,966,050 | Bucher (1980) |
| 1980 | 96.0 | 78 | 4.0 | 4.0 | 95 | 6.8 | 48,295,932 | Bucher (1981) |
| 1981 | 66.1 | 88 | 6.3 | 33.9 | 96 | 8.4 | 97,527,446 | Bucher (1982) |
| 1982 | 87.3 | 79 | 4.7 | 12.7 | 98 | 8.4 | 37,061,837 | Bucher (1984) |
| 1983 | 82.6 | 86 | 6.5 | 17.4 | 98 | 9.2 | 23,728,252 | Bucher (1987) |
| 1984 | 94.2 | 92 | 7.8 | 5.8 | 97 | 8.7 | 23,710,947 | Bucher (1986) |
| 1985 | 87.2 | 92 | 7.2 | 12.8 | 91 | 7.1 | 36,640,969 | Bucher (1986) |
| 1986 | 97.9 | 87 | 5.9 | 2.1 | 101 | 9.2 | 54,661,948 | Bue et al. (1988) |
| 1987 | 92.6 | 86 | 5.8 | 7.4 | 100 | 8.7 | 36,227,371 | Cross et al. (1990) |
| 1988 | 97.0 | 87 | 6.3 | 3.0 | 100 | 9.2 | 40,799,537 | Woolington et al. (1990) |
| Mean | 89.2 | 84 | 6.0 | 10.8 | 100 | 8.6 | | |
| 1989 | 91.3 | 91 | 7.8 | 8.7 | 98 | 9.1 | 41,229,040 | |

[a] Fyke net catches used to index abundance of smolt, 1951-66.

[b] Hydroacoustic equipment used to estimate numbers of smolt, 1975-89.

Table 40. Infection of age-I and age-II Wood River sockeye salmon smolt by the cestode Triaenophorus crassus, 1989.

| | Age I | | Age II | | | Age I | | Age II | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Number Examined | Number Infected | Number Examined | Number Infected | Date | Number Examined | Number Infected | Number Examined | Number Infected |
| 6 10 | 6 | 6 | 3 | 3 | 7 07 | 4 | 3 | 0 | 0 |
| 6 11 | 111 | 78 | 9 | 9 | 7 08 | 115 | 100 | 1 | 1 |
| 6 12 | 94 | 67 | 1 | 1 | 7 09 | 5 | 3 | 0 | 0 |
| 6 13 | 7 | 4 | 0 | 0 | 7 10 | 119 | 93 | 0 | 0 |
| 6 14 | 98 | 29 | 3 | 3 | 7 11 | 73 | 44 | 3 | 2 |
| 6 15 | 116 | 91 | 4 | 4 | 7 12 | 11 | 9 | 0 | 0 |
| 6 16 | 120 | 97 | 0 | 0 | 7 14 | 4 | 1 | 0 | 0 |
| 6 17 | 114 | 80 | 6 | 6 | 7 17 | 6 | 1 | 0 | 0 |
| 6 18 | 4 | 4 | 0 | 0 | 7 18 | 6 | 5 | 0 | 0 |
| 6 19 | 29 | 20 | 2 | 2 | 7 19 | 3 | 0 | 0 | 0 |
| 6 20 | 9 | 6 | 0 | 0 | 7 21 | 8 | 5 | 1 | 1 |
| 6 21 | 58 | 36 | 1 | 1 | 7 22 | 2 | 0 | 0 | 0 |
| 6 22 | 60 | 41 | 0 | 0 | 7 23 | 7 | 7 | 0 | 0 |
| 6 23 | 48 | 32 | 0 | 0 | 7 24 | 8 | 8 | 0 | 0 |
| 6 24 | 83 | 60 | 3 | 2 | 7 29 | 6 | 2 | 0 | 0 |
| 6 25 | 4 | 1 | 2 | 1 | 7 30 | 113 | 47 | 1 | 0 |
| 6 26 | 2 | 1 | 0 | 0 | 7 31 | 91 | 42 | 1 | 1 |
| 6 27 | 98 | 67 | 1 | 1 | 8 01 | 37 | 12 | 0 | 0 |
| 6 28 | 13 | 6 | 3 | 0 | 8 02 | 108 | 65 | 3 | 1 |
| 6 29 | 119 | 98 | 1 | 1 | 8 03 | 98 | 51 | 0 | 0 |
| 6 30 | 9 | 5 | 1 | 1 | 8 04 | 87 | 47 | 0 | 0 |
| 7 04 | 115 | 77 | 5 | 3 | 8 05 | 92 | 65 | 0 | 0 |
| 7 05 | 119 | 95 | 0 | 0 | 8 06 | 90 | 47 | 0 | 0 |
| | | | | | Total | 2,528 | 1,658 | 98 | 44 |

Table 41. Infection of Wood River sockeye salmon smolt by the cestode Triaenophorus crassus, 1978-1989.

| Year | Percent Infected | | References |
|---|---|---|---|
| | Age I | Age II | |
| 1978 | 15.1 | 40.5 | Clark and Robertson (1980) |
| 1979 | 10.0 | 30.8 | Bucher (1980) |
| 1980 | 11.1 | 17.3 | Bucher (1981) |
| 1981 | 28.2 | 35.6 | Bucher (1982) |
| 1982 | 10.0 | 21.2 | Bucher (1984) |
| 1983 | 43.1 | 73.6 | Bucher (1987) |
| 1984 | 41.1 | 45.7 | Bucher (1986) |
| 1985 | 35.7 | 41.5 | Bucher (1986) |
| 1986 | 40.8 | 45.6 | Bue et al. (1988) |
| 1987 | 42.6 | 57.8 | Cross et al. (1990) |
| 1988 | 40.8 | 46.4 | Woolington et al. (1990) |
| Mean | 29.0 | 41.5 | |
| 1989 | 65.6 | 44.9 | |

Table 42. Climatological and hydrological observations made at sockeye salmon smolt counting site, Wood River, 1989.

| Date | Cloud Cover[a] | | Wind Velocity (km/hr) | | Air Temp. (Min/Max °C) | | Water Temp. (°C) | | Precipitation (mm) | Water Clarity |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0800 hours | 2000 hours | 0800 hours | 2000 hours | 0800 hours | 2000 hours | 0800 hours | 2000 hours | | |
| 6 09 | 4 | 2 | - | - | 7/22 | 12/16 | 8.0 | 8.0 | 0.2 | clear |
| 6 10 | 4 | 2 | - | - | 8/22 | 16/23 | 8.0 | 8.0 | 0.0 | clear |
| 6 11 | 2 | 4 | calm | calm | 9/23 | 11/20 | 8.0 | 8.0 | 0.2 | clear |
| 6 12 | 1 | 1 | calm | calm | 10/25 | 17/22 | 8.0 | 8.0 | 0.0 | clear |
| 6 13 | 4 | 4 | calm | 5-10 SE | 9/2/ | 11/20 | 8.0 | 8.0 | 0.0 | clear |
| 6 14 | 1 | 4 | calm | 5-10 SE | 7/20 | 14/21 | 8.0 | 8.0 | 0.4 | clear |
| 6 15 | 4 | 4 | 5 SE | 5-10 SE | 3/22 | 3/12 | 8.0 | 8.0 | 20.0 | clear |
| 6 16 | 1 | 1 | 5-10 SE | 5-10 SE | 8/22 | 12/22 | 8.0 | 8.0 | 0.0 | clear |
| 6 17 | 1 | 1 | calm | 10-20 NW | 7/28 | 19/23 | 8.0 | 8.0 | 0.0 | clear |
| 6 18 | 4 | 0 | 5-10 NW | 5-10 NW | 5/22 | 19/23 | 8.0 | 8.0 | 0.0 | clear |
| 6 19 | 2 | 1 | calm | 10-20 SE | 2/20 | 20/24 | 8.0 | 8.0 | 0.0 | clear |
| 6 20 | 4 | 4 | 10-15 SE | 20-30 SE | 2/20 | 13/20 | 8.0 | 8.0 | 0.3 | clear |
| 6 21 | 4 | 4 | 5-10 SE | calm | 2/20 | 11/21 | 7.0 | 7.0 | 10.0 | clear |
| 6 22 | 4 | 4 | calm | 20-30 SE | 2/20 | 10/20 | 5.0 | 5.0 | 20.0 | clear |
| 6 23 | 4 | 4 | 5-15 SE | 5-10 SE | 7/20 | 11/20 | 6.0 | 6.0 | 0.2 | clear |
| 6 24 | 1 | 1 | 5-10 NW | calm | 6/12 | 11/20 | 6.0 | 7.0 | 0.0 | clear |
| 6 25 | 1 | 4 | calm | calm | 2/17 | 11/20 | 7.0 | 7.0 | 0.0 | clear |
| 6 26 | 4 | 4 | calm | calm | 8/20 | 13/20 | 8.0 | 8.0 | 0.5 | clear |
| 6 27 | 1 | 1 | calm | calm | 7/12 | 11/12 | 8.0 | 8.0 | 0.0 | clear |
| 6 28 | 1 | 2 | calm | calm | 6/12 | 10/15 | 8.0 | 8.5 | 0.0 | clear |
| 6 29 | 4 | 3 | calm | calm | 5/12 | 11/26 | 8.0 | 8.0 | 0.0 | clear |
| 6 30 | 1 | 2 | calm | calm | 5/11 | 11/28 | 8.0 | 8.5 | 0.9 | clear |
| 7 01 | 1 | 1 | calm | calm | 10/14 | 11/30 | 8.0 | 8.0 | 0.0 | clear |
| 7 02 | 1 | 1 | calm | calm | 9/14 | 15/26 | 9.5 | 12.5 | 0.0 | clear |
| 7 03 | 1 | 1 | calm | calm | 5/15 | 11/28 | 12.5 | 12.0 | 0.0 | clear |
| 7 04 | 4 | 5 | calm | calm | 11/14 | 11/28 | 12.0 | 12.0 | 0.0 | clear |
| 7 05 | 4 | 4 | calm | 5-15 SE | 5/14 | 9/12 | 8.0 | 11.0 | 3.0 | clear |
| 7 06 | 4 | 4 | 5-10 SE | 5-15 SE | 10/11 | 9/15 | 10.5 | 10.0 | 12.0 | clear |
| 7 07 | 4 | 4 | 5-15 SE | 5 SE | 10/14 | 10/14 | 10.0 | 9.0 | 12.0 | clear |
| 7 08 | 4 | 4 | calm | 5-10 SE | 10/15 | 11/14 | 9.0 | 10.0 | 2.0 | clear |
| 7 09 | 3 | 1 | calm | calm | 4/10 | 8/19 | 8.5 | 9.0 | 1.0 | clear |
| 7 10 | 4 | 4 | calm | calm | 7/18 | 15/19 | 9.5 | 10.0 | 0.0 | clear |
| 7 11 | 1 | 4 | 5-10 S | calm | 9/14 | 12/20 | 9.0 | 10.0 | 0.0 | clear |
| 7 12 | 1 | 3 | calm | calm | 8/13 | 13/15 | 9.0 | 9.5 | 2.0 | clear |
| 7 13 | 1 | 4 | 10 SE | 5-15 SE | 8/14 | 12/13 | 9.0 | 9.0 | 12.0 | clear |
| 7 14 | 4 | 4 | 10-15 SE | calm | 8/11 | 10/13 | 9.0 | 8.0 | 51.0 | clear |
| 7 15 | 4 | 3 | 0-5 SE | calm | 8/11 | 10/17 | 8.5 | 8.5 | 2.0 | clear |
| 7 16 | 2 | 2 | 0-5 SE | calm | 10/12 | 13/19 | 9.0 | 8.5 | 2.0 | clear |
| 7 17 | 2 | 1 | 0-5 NW | calm | 10/15 | 17/25 | 10.0 | 11.0 | 0.0 | clear |
| 7 18 | 4 | 4 | 0-10 NW | calm | 9/15 | 13/20 | 10.0 | 10.5 | 0.0 | clear |
| 7 19 | 4 | 4 | 0-5 S | 0-5 SE | 8/11 | 13/18 | 10.0 | 10.5 | 0.0 | clear |
| 7 20 | 4 | 1 | 0-5 NW | 5 SE | 7/14 | 14/17 | 10.0 | 10.5 | 0.0 | clear |
| 7 21 | 4 | 4 | 0-5 NW | 5-10 SE | 6/20 | 11/15 | 10.5 | 10.0 | 0.0 | clear |
| 7 22 | 4 | 4 | calm | calm | 5/22 | 13/14 | 10.5 | 10.5 | 0.0 | clear |
| 7 23 | 4 | 1 | 5-10 SE | calm | 5/15 | 12/21 | 10.5 | 10.5 | 0.0 | clear |
| 7 24 | 3 | 1 | 5-10 SE | 5-10 SE | 6/21 | 14/22 | 11.0 | 11.0 | 0.0 | clear |
| 7 25 | 1 | 1 | 0-5 SE | calm | 6/21 | 20/23 | 12.0 | 11.0 | 0.0 | clear |
| 7 26 | 1 | 1 | 0-10 NW | 5-10 SE | 6/21 | 21/24 | 12.0 | 11.0 | 0.0 | clear |

-Continued-

Table 42. (p 2 of 2).

| Date | Cloud Cover[a] 0800 hours | Cloud Cover[a] 2000 hours | Wind Velocity (km/hr) 0800 hours | Wind Velocity (km/hr) 2000 hours | Air Temp. (Min/Max °C) 0800 hours | Air Temp. (Min/Max °C) 2000 hours | Water Temp. (°C) 0800 hours | Water Temp. (°C) 2000 hours | Precipitation (mm) | Water Clarity |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 27 | 4 | 4 | 5-15 NW | 5-10 SE | 6/24 | 15/24 | 12.0 | 11.5 | 0.0 | clear |
| 7 28 | 4 | 3 | calm | 5-10 SE | 5/13 | 14/19 | 12.0 | 11.5 | 2.0 | clear |
| 7 29 | 4 | 4 | 5-20 SE | 0-20 SE | 12/14 | 13/13 | 12.0 | 11.5 | 24.0 | clear |
| 7 30 | 4 | 4 | calm | 0-5 S | 10/12 | 13/13 | 12.0 | 10.0 | 10.0 | clear |
| 7 31 | 4 | 4 | calm | calm | 11/12 | 11/14 | 12.0 | 10.0 | 4.0 | clear |
| 8 01 | 4 | 3 | calm | calm | 10/12 | 10/13 | 12.0 | 11.5 | 10.0 | clear |
| 8 02 | 4 | 3 | calm | calm | 10/12 | 10/17 | 11.5 | 11.0 | 0.0 | clear |
| 8 03 | 3 | 3 | calm | calm | 10/12 | 11/13 | 11.0 | 11.0 | 4.0 | clear |
| 8 04 | 4 | 3 | calm | calm | 12/14 | 11/26 | 11.0 | 11.0 | 0.0 | clear |
| 8 05 | 3 | 3 | calm | 5-10 NW | 13/16 | 22/25 | 11.0 | 11.0 | 0.0 | clear |
| 8 06 | 4 | 3 | calm | calm | 12/19 | 14/23 | 11.0 | 11.5 | 0.0 | clear |
| 8 07 | 4 | - | 5-15 NW | calm | 12/14 | - | 11.0 | - | 0.1 | clear |

[a] 1 = cloud cover not more than 1/10
2 = cloud cover not more than 1/2
3 = cloud cover more than 1/2
4 = completely overcast
5 = fog

Table 43. Water temperatures and depths at sockeye salmon smolt counting site, Wood River (outlet of Lake Aleknagik), 1975-1989.

| Year | Sample Period | Water Temperature (°C) Minimum | Maximum | Mean | |
|---|---|---|---|---|---|
| 1975 | May 29 - Jul 19 | 2.0 | 9.5 | 5.0 | Krasnowski (1976) |
| 1976 | Jun 09 - Aug 07 | 2.0 | 14.0 | 8.0 | Krasnowski (1977) |
| 1977 | Jun 09 - Aug 08 | 4.5 | 15.5 | 9.0 | Newcome (1978) |
| 1978 | May 28 - Aug 09 | 5.0 | 16.0 | 9.0 | Clark and Robertson (1980) |
| 1979 | May 30 - Aug 02 | 4.5 | 16.0 | 9.0 | Bucher (1980) |
| 1980 | May 30 - Aug 15 | 4.5 | 18.0 | 9.0 | Bucher (1981) |
| 1981 | May 27 - Aug 13 | 5.4 | 17.5 | 11.4 | Bucher (1982) |
| 1982 | May 27 - Aug 10 | 2.2 | 12.0 | 6.4 | Bucher (1984) |
| 1983 | May 28 - Jul 26 | 4.4 | 12.8 | 8.7 | Bucher (1987) |
| 1984 | May 22 - Jul 27 | 4.4 | 16.7 | 10.8 | Bucher (1986) |
| 1985 | Jun 06 - Aug 08 | 2.2 | 10.6 | 6.3 | Bucher (1986) |
| 1986 | May 23 - Jul 17 | 3.0 | 10.5 | 6.1 | Bucher et al. (1988) |
| 1987 | May 23 - Aug 05 | 4.0 | 16.0 | 6.8 | Cross et al. (1990) |
| 1988 | Jun 03 - Aug 01 | 3.5 | 15.5 | 8.8 | Woolington et al (1990) |
| | Mean | 3.7 | 14.3 | 8.2 | |
| 1989 | Jun 09 - Aug 07 | 5.0 | 12.5 | 9.3 | |

Table 44. Sonar counts recorded from three arrays each with 10 transducers at the sockeye salmon smolt counting site on the Nuyakuk River, 1989.

| Date[a] | Transducer Array | | | Total |
|---|---|---|---|---|
| | Inshore | Center | Offshore | |
| 5 29 | 14 | 8 | 51 | 73 |
| 5 30 | 0 | 0 | 0 | 0 |
| 5 31 | 0 | 0 | 0 | 0 |
| 6 01 | 0 | 0 | 0 | 0 |
| 6 02 | 0 | 0 | 0 | 0 |
| 6 03 | 102 | 244 | 201 | 547 |
| 6 04 | 209 | 483 | 982 | 1,674 |
| 6 05 | 347 | 746 | 915 | 2,008 |
| 6 06 | 489 | 1,254 | 1,203 | 2,946 |
| 6 07 | 723 | 1,200 | 1,446 | 3,369 |
| 6 08 | 714 | 1,544 | 1,886 | 4,144 |
| 6 09 | 1,448 | 4,253 | 4,130 | 9,831 |
| 6 10 | 997 | 3,277 | 2,526 | 6,800 |
| 6 11 | 572 | 1,032 | 1,137 | 2,741 |
| 6 12 | 3,795 | 18,816 | 11,874 | 34,485 |
| 6 13 | 2,735 | 10,905 | 14,784 | 28,424 |
| 6 14 | 5,630 | 10,021 | 8,053 | 23,704 |
| 6 15 | 1,586 | 5,096 | 5,948 | 12,630 |
| 6 16 | 2,005 | 5,676 | 6,272 | 13,953 |
| 6 17 | 1,317 | 3,505 | 3,628 | 8,450 |
| 6 18 | 627 | 2,005 | 1,604 | 4,236 |
| 6 19 | 209 | 491 | 614 | 1,314 |
| 6 20 | 224 | 485 | 528 | 1,237 |
| 6 21 | 166 | 239 | 172 | 577 |
| 6 22 | 288 | 180 | 240 | 708 |
| 6 23 | 77 | 145 | 119 | 341 |
| Total | 24,274 | 71,605 | 68,313 | 164,192 |
| Percent | 14.8 | 43.6 | 41.6 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 45. Velocity correction factors used at Nuyakuk River, 1989.

| Date | Inshore | Center | Offshore |
|---|---|---|---|
| May 29 - May 31 | 1.00 | 1.04 | 0.96 |
| Jun 01 - Jun 02 | 1.00 | 0.86 | 0.79 |
| Jun 03 | 1.00 | 1.02 | 1.05 |
| Jun 04 - Jun 05 | 1.00 | 0.88 | 0.91 |
| Jun 06 - Jun 07 | 1.00 | 0.83 | 0.86 |
| Jun 08 - Jun 12 | 1.00 | 1.00 | 1.03 |
| Jun 13 - Jun 14 | 1.00 | 1.08 | 1.08 |
| Jun 15 - Jun 17 | 1.00 | 1.01 | 1.01 |
| Jun 18 - Jun 23 | 1.00 | 0.98 | 1.02 |

Table 46. Daily number of sockeye salmon smolt, estimated with hydroacoustic equipment, Nuyakuk River, 1989.

| | Age I | | | Age II | | | All Ages | |
|---|---|---|---|---|---|---|---|---|
| Date[a] | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 5 29 | 2,525 | 88.5 | 2,525 | 326 | 11.5 | 326 | 2,851 | 2,851 |
| 5 30 | 0 | 88.5 | 2,525 | 0 | 11.5 | 326 | 0 | 2,851 |
| 5 31 | 0 | 88.5 | 2,525 | 0 | 11.5 | 326 | 0 | 2,851 |
| 6 01 | 0 | 88.5 | 2,525 | 0 | 11.5 | 326 | 0 | 2,851 |
| 6 02 | 0 | 88.5 | 2,525 | 0 | 11.5 | 326 | 0 | 2,851 |
| 6 03 | 18,609 | 88.5 | 21,134 | 2,408 | 11.5 | 2,734 | 21,017 | 23,868 |
| 6 04 | 51,171 | 88.5 | 72,305 | 6,623 | 11.5 | 9,357 | 57,794 | 81,662 |
| 6 05 | 60,478 | 88.5 | 132,783 | 7,827 | 11.5 | 17,184 | 68,305 | 149,967 |
| 6 06 | 82,938 | 88.5 | 215,721 | 10,734 | 11.5 | 27,918 | 93,672 | 243,639 |
| 6 07 | 95,976 | 88.5 | 311,697 | 12,422 | 11.5 | 40,340 | 108,398 | 352,037 |
| 6 08 | 135,891 | 88.5 | 447,588 | 17,588 | 11.5 | 57,928 | 153,479 | 505,516 |
| 6 09 | 329,296 | 90.1 | 776,884 | 36,020 | 9.9 | 93,948 | 365,316 | 870,832 |
| 6 10 | 224,953 | 90.1 | 1,001,837 | 24,606 | 9.9 | 118,554 | 249,559 | 1,120,391 |
| 6 11 | 98,869 | 92.3 | 1,100,706 | 8,248 | 7.7 | 126,802 | 107,117 | 1,227,508 |
| 6 12 | 1,214,659 | 92.3 | 2,315,365 | 101,331 | 7.7 | 228,133 | 1,315,990 | 2,543,498 |
| 6 13 | 962,831 | 88.6 | 3,278,196 | 123,640 | 11.4 | 351,773 | 1,086,471 | 3,629,969 |
| 6 14 | 787,481 | 88.6 | 4,065,677 | 101,123 | 11.4 | 452,896 | 888,604 | 4,518,573 |
| 6 15 | 448,701 | 92.9 | 4,514,378 | 34,396 | 7.1 | 487,292 | 483,097 | 5,001,670 |
| 6 16 | 491,467 | 92.9 | 5,005,845 | 37,674 | 7.1 | 524,966 | 529,141 | 5,530,811 |
| 6 17 | 283,469 | 92.9 | 5,289,314 | 21,730 | 7.1 | 546,696 | 305,199 | 5,836,010 |
| 6 18 | 155,722 | 95.1 | 5,445,036 | 8,006 | 4.9 | 554,702 | 163,728 | 5,999,738 |
| 6 19 | 49,346 | 95.1 | 5,494,382 | 2,537 | 4.9 | 557,239 | 51,883 | 6,051,621 |
| 6 20 | 40,837 | 89.5 | 5,355,219 | 4,790 | 10.5 | 562,029 | 45,627 | 6,097,248 |
| 6 21 | 18,148 | 89.5 | 5,533,670 | 2,129 | 10.5 | 564,158 | 20,277 | 6,117,525 |
| 6 22 | 22,134 | 89.5 | 5,575,491 | 2,596 | 10.5 | 566,754 | 24,730 | 6,142,245 |
| 6 23 | 10,961 | 89.5 | 5,586,452 | 1,285 | 10.5 | 568,039 | 12,246 | 6,154,491 |
| | 5,586,452 | 90.8 | | 568,039 | 9.2 | | 6,154,491 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 47. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Nuyakuk River, 1989.

| Date[a] | Mean Weight of Smolt (g) | Smolt per Count |
|---|---|---|
| 5 29 | 5.4 | 7.6 |
| 5 30 | 5.4 | 7.6 |
| 5 31 | 5.4 | 7.6 |
| 6 01 | 5.4 | 7.6 |
| 6 02 | 5.4 | 7.6 |
| 6 03 | 5.4 | 7.6 |
| 6 04 | 5.4 | 7.6 |
| 6 05 | 5.4 | 7.6 |
| 6 06 | 5.4 | 7.6 |
| 6 07 | 5.4 | 7.6 |
| 6 08 | 5.4 | 7.6 |
| 6 09 | 5.4 | 7.7 |
| 6 10 | 5.4 | 7.7 |
| 6 11 | 5.1 | 8.2 |
| 6 12 | 5.1 | 8.2 |
| 6 13 | 5.4 | 7.7 |
| 6 14 | 5.4 | 7.7 |
| 6 15 | 5.1 | 8.2 |
| 6 16 | 5.1 | 8.2 |
| 6 17 | 5.1 | 8.2 |
| 6 18 | 4.7 | 8.9 |
| 6 19 | 4.7 | 8.9 |
| 6 20 | 5.0 | 8.4 |
| 6 21 | 5.0 | 8.4 |
| 6 22 | 5.0 | 8.4 |
| 6 23 | 5.0 | 8.4 |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 48. Sockeye salmon spawning escapements, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1980-1987 brood years, Nuyakuk River.

| Brood Year | Total Spawning Escapement | Number of Smolt Produced | | | |
|---|---|---|---|---|---|
| | | Age I (%)[a] | Age II (%)[a] | Total | Per Spawner |
| 1980 | 3,026,568 | - | 1,259,339 | - | - |
| 1981 | 834,204 | 28,875,158 (99) | 89,911 ( 1) | 28,965,069 | 34.72 |
| 1982 | 537,864 | 6,293,644 (89) | 769,319 (11) | 7,062,963 | 13.13 |
| 1983 | 318,606 | 22,596,725 (99) | 172,411 ( 1) | 22,769,136 | 71.46 |
| 1984 | 472,596 | 11,063,753 (96) | 495,634 ( 4) | 11,559,387 | 24.46 |
| 1985 | 429,162 | 7,280,226 (96) | 288,237 ( 4) | 7,568,463 | 17.63 |
| 1986 | 821,898 | 8,305,313 (94) | 568,039 ( 6) | 8,873,352 | 10.80 |
| 1987 | 163,000 | 5,586,452 | | | |

[a] Percent of total smolt production

Table 49. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1987 brood years, Nuyakuk River.

| Brood Year | Total Spawning Escapement | Age I | | | Age II | | |
|---|---|---|---|---|---|---|---|
| | | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt | Number of Smolt | Adult[a] Returns | Adult Returns per Smolt |
| 1980 | 3,026,568 | - | 643,982 | | 1,259,339 | 212,695 | 0.17 |
| 1981 | 834,204 | 28,875,158 | 2,022,007 | 0.07 | 89,911 | 26,895 | 0.30 |
| 1982 | 537,864 | 6,293,644 | 615,403 | 0.10 | 769,319 | 10,430 | 0.01 |
| 1983 | 318,606 | 22,596,725 | 667,137 | 0.03 | 172,411 | 2,154 | 0.01 |
| 1984 | 472,596 | 11,063,753 | 50,436 | 0.01 | 495,634 | 0 | 0.00 |
| 1985 | 429,162 | 7,280,226 | 0 | 0.00 | 288,237 | - | -[b] |
| 1986 | 821,898 | 8,305,313 | - | -[b] | 568,039 | - | -[b] |
| 1987 | 163,000 | 5,586,452 | - | -[b] | | | |

[a] Includes estimates of returns through 1988.

[b] 1988 was the last year that adult return to the Nuyakuk River was monitored.

Table 50. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Nuyakuk River, 1989.

| | Age I | | | | | Age II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size | Mean Length (mm) | Std. Error | Mean Weight (g) | Std. Error | Sample Size |
| 6 03 | 81 | 14.2 | 4.7 | 2.31 | 28 | 97 | 7.7 | 7.3 | 1.55 | 2 |
| 6 05 | 83 | 9.9 | 4.9 | 2.29 | 36 | 97 | | 7.0 | | 1 |
| 6 06 | 83 | 12.3 | 4.7 | 1.93 | 29 | 100 | 1.6 | 8.7 | 0.81 | 3 |
| 6 07 | 85 | 13.3 | 5.3 | 2.56 | 87 | 99 | 6.0 | 8.4 | 1.63 | 12 |
| 6 08 | 86 | 14.5 | 5.5 | 3.10 | 72 | 101 | 8.2 | 8.7 | 2.05 | 27 |
| 6 09 | 87 | 15.7 | 6.1 | 3.86 | 76 | 100 | 10.0 | 8.8 | 2.68 | 23 |
| 6 10 | 82 | 12.9 | 4.9 | 2.58 | 92 | 95 | 8.6 | 7.2 | 2.17 | 8 |
| 6 11 | 80 | 17.2 | 4.5 | 2.63 | 92 | 98 | 5.3 | 8.1 | 1.34 | 7 |
| 6 12 | 83 | 17.3 | 5.0 | 2.98 | 95 | 94 | 3.1 | 6.7 | 0.33 | 3 |
| 6 13 | 83 | 14.4 | 5.3 | 3.00 | 81 | 102 | 8.8 | 9.2 | 2.33 | 18 |
| 6 14 | 83 | 15.6 | 5.1 | 2.96 | 92 | 93 | 15.2 | 7.1 | 3.09 | 8 |
| 6 16 | 82 | 16.0 | 5.0 | 2.96 | 91 | 98 | 6.5 | 8.1 | 1.54 | 9 |
| 6 17 | 84 | 15.0 | 5.3 | 3.02 | 95 | 98 | 5.1 | 7.8 | 1.20 | 5 |
| 6 18 | 81 | 18.2 | 4.7 | 3.23 | 95 | 93 | 9.2 | 6.8 | 2.13 | 5 |
| 6 19 | 77 | 19.9 | 4.3 | 3.12 | 95 | 94 | 13.1 | 7.0 | 3.34 | 5 |
| 6 20 | 77 | 14.7 | 4.4 | 2.68 | 49 | 87 | | 5.2 | | 1 |
| 6 21 | 84 | 10.2 | 5.6 | 1.69 | 4 | 89 | 1.2 | 6.1 | .54 | 2 |
| 6 22 | 81 | 9.7 | 4.8 | 2.13 | 9 | | | | | 0 |
| Totals | | | | | 1,218 | | | | | 139 |
| Means | 82 | | 5.0 | | | 96 | | 7.5 | | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 51. Mean fork length and weight by age class, for sockeye salmon smolt, Nuyakuk River, 1978, and 1982-1989.

| Year of Migration | Sample Dates | Sample Size | Age I Mean Length (mm) | Age I Mean Weight (g) | Age II Mean Length (mm) | Age II Mean Weight (g) | References |
|---|---|---|---|---|---|---|---|
| 1978 | Jun 18 - Jun 19 | 350 | 71 | 4.3 | 85 | 5.8 | Huttunen (1980) |
| 1982 | Jun 15 - Jul 09 | 208 | 76 | 3.9 | 96 | 6.8 | Minard (1984) |
| 1983 | May 27 - Jun 30 | 1,847 | 75 | 4.3 | 91 | 6.6 | Minard and Frederickson (1987) |
| 1984 | May 27 - Jun 26 | 980 | 81 | 4.9 | 93 | 7.3 | Minard and Frederickson (1986) |
| 1985 | May 24 - Jun 28 | 1,479 | 85 | 5.5 | 89 | 6.6 | Minard and Brandt (1986) |
| 1986 | May 24 - Jun 27 | 1,840 | 81 | 4.7 | 91 | 6.2 | Bue et al. (1988) |
| 1987 | May 29 - Jun 27 | 1,597 | 78 | 4.1 | 91 | 6.2 | Cross et al. (1990) |
| 1988 | May 29 - Jun 27 | 2,612 | 75 | 3.6 | 85 | 5.1 | Woolington et al. (1990) |
| | | Mean | 78 | 4.5 | 91 | 6.5 | |
| 1989 | Jun 03 - Jun 22 | 1,357 | 82 | 5.0 | 96 | 7.5 | |

Table 52. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Nuyakuk River, 1989.

| | Estimated Age I | | | | Estimated Age II | | | |
|---|---|---|---|---|---|---|---|---|
| Date[a] | Mean Length (mm) | Std. Error | Estimated Weight (g) | Sample Size | Mean Length (mm) | Std. Error | Estimated Weight (g) | Sample Size |
| 6 07[b] | 83 | 17.2 | 5.2 | 162 | 98 | 6.1 | 8.1 | 18 |
| 6 08 | 83 | 14.9 | 5.1 | 176 | 100 | 6.6 | 8.5 | 25 |
| 6 09 | 82 | 17.0 | 4.9 | 210 | 99 | 4.6 | 8.2 | 17 |
| 6 10 | 82 | 18.0 | 4.9 | 194 | 101 | 8.3 | 8.9 | 17 |
| 6 11 | 80 | 19.3 | 4.6 | 181 | 100 | 4.2 | 8.6 | 7 |
| 6 12 | 84 | 19.6 | 5.2 | 178 | 99 | 7.1 | 8.3 | 31 |
| 6 13 | 83 | 17.8 | 5.1 | 199 | 100 | 5.8 | 8.5 | 28 |
| 6 14 | 83 | 18.4 | 5.0 | 199 | 99 | 6.1 | 8.3 | 26 |
| 6 16 | 80 | 18.6 | 4.6 | 124 | 99 | 3.0 | 8.3 | 2 |
| 6 17 | 81 | 22.5 | 4.7 | 199 | 101 | 8.6 | 8.8 | 21 |
| 6 18 | 80 | 23.7 | 4.7 | 222 | 97 | 4.6 | 7.8 | 15 |
| 6 19 | 77 | 20.1 | 4.2 | 100 | | | | 0 |
| Totals | | | | 2,144 | | | | 207 |
| Means | 81 | | 4.9 | | 99 | | 8.4 | |

[a] Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

[b] Length-weight parameters by age group and discriminating length used to separate ages from May 29 through June 23 were:
age I a= -10.45 b= 2.73 $r^2$= 0.81 n= 1,218
age II a= -11.81 b= 3.03 $r^2$= 0.87 n= 139
discriminating length = 94.22

Table 53. Climatological and hydrological observations made at sockeye salmon smolt counting site, Nuyakuk River, 1989.

| Date | Cloud Cover[a] | | Wind Velocity (km/hr) | | Air Temp. (°C) | | Water Temp. (°C) | | Precipitation (mm) | Water Clarity |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0800 hours | 2000 hours | 0800 hours | 2000 hours | 0800 hours | 2000 hours | 0800 hours | 2000 hours | | |
| 5 29 | 4 | 4 | calm | calm | 11.0 | 8.0 | 2.5 | 3.0 | trace | murky |
| 5 30 | 5 | 3 | calm | 5 E | 5.0 | 10.0 | 3.0 | 3.0 | 4.0 | murky |
| 5 31 | 4 | 3 | calm | 5-10 E | 5.0 | 8.0 | 3.0 | 3.0 | 4.0 | murky |
| 6 01 | 5 | 4 | calm | 5-10 NE | 5.0 | 8.0 | 3.0 | 3.0 | 6.5 | murky |
| 6 02 | 4 | 3 | 5-10 NE | 10 SE | 5.0 | 10.0 | 3.0 | 3.0 | 5.0 | murky |
| 6 03 | 4 | 4 | gusts NE | 0-5 SE | 7.0 | 8.0 | 3.0 | 3.0 | 2.5 | murky |
| 6 04 | 5 | 3 | calm | calm | 6.0 | 14.0 | 4.0 | 4.0 | 5.0 | murky |
| 6 05 | 3 | 3 | calm | calm | 7.0 | 11.0 | 4.0 | 4.0 | 0.0 | murky |
| 6 06 | 1 | 3 | calm | calm | 6.0 | 12.0 | 3.0 | 4.0 | 0.0 | murky |
| 6 07 | 3 | 4 | calm | calm | 5.0 | 16.0 | 3.0 | 4.0 | 0.0 | murky |
| 6 08 | 3 | 4 | calm | 15 SE | 7.0 | 14.0 | 3.5 | 4.0 | 0.0 | murky |
| 6 09 | 4 | 2 | 5-10 NE | 20 SE | 6.0 | 14.0 | 3.5 | 4.0 | trace | murky |
| 6 10 | 1 | 3 | 0-5 N | 0-5 N | 10.0 | 15.0 | 3.5 | 4.0 | 0.0 | murky |
| 6 11 | 4 | 3 | calm | calm | 8.0 | 12.0 | 4.0 | 4.0 | 0.0 | murky |
| 6 12 | 1 | 2 | 0-5 N | calm | 10.0 | 16.0 | 5.0 | 5.0 | 0.0 | murky |
| 6 13 | 3 | 3 | calm | calm | 8.0 | - | 4.0 | - | trace | murky |
| 6 14 | 3 | 4 | calm | 0-5 SE | 10.0 | - | 5.0 | 5.0 | trace | murky |
| 6 15 | 4 | 2 | 5-10 SE | calm | 6.0 | 9.0 | 5.0 | 5.0 | 21.5 | murky |
| 6 16 | 2 | 2 | 5 N | 5 NE | 10.0 | 13.0 | 5.0 | 6.0 | 0.0 | murky |
| 6 17 | 1 | 2 | 0-5 NW | 0-5 NW | 6.0 | 20.0 | 5.0 | 7.0 | 0.0 | murky |
| 6 18 | 3 | 2 | 0-5 NW | 0-5 NW | 8.0 | 18.0 | 5.0 | 6.0 | 0.0 | murky |
| 6 19 | 2 | 1 | 0-5 SE | 15-20 SE | 13.0 | 18.0 | 6.0 | 7.0 | 0.0 | murky |
| 6 20 | 3 | 4 | 15-20 SE | 10-15 SE | 10.0 | 11.0 | 6.0 | 6.0 | 0.0 | murky |
| 6 21 | 4 | 4 | 5-10 SE | 0-5 SE | 9.0 | 11.0 | 6.0 | 6.0 | 0.0 | murky |
| 6 22 | 4 | 4 | 0-5 NE | 0-5 NE | 8.0 | 10.0 | 6.0 | 7.0 | 5.0 | murky |
| 6 23 | 4 | 4 | 0-5 SE | 0-5 SE | 7.5 | 9.0 | 6.0 | 7.0 | 2.5 | murky |

[a] 1 = cloud cover not more than 1/10
2 = cloud cover not more than 1/2
3 = cloud cover more than 1/2
4 = completely overcast
5 = fog

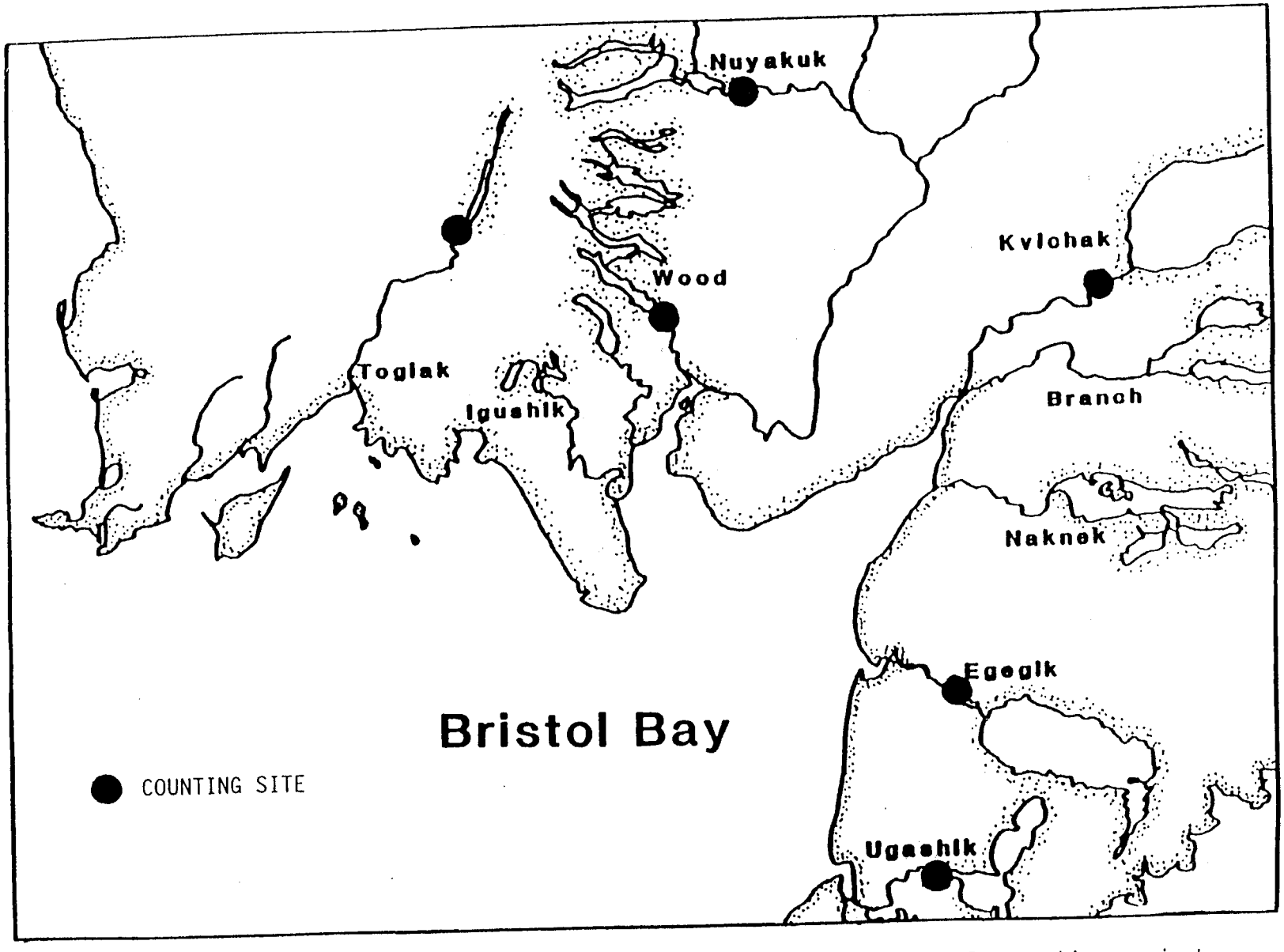



Figure 1. Bristol Bay Management Area with major rivers and locations of smolt counting projects.

## APPENDIX A

*Kvichak River Smolt Operations in 1989*

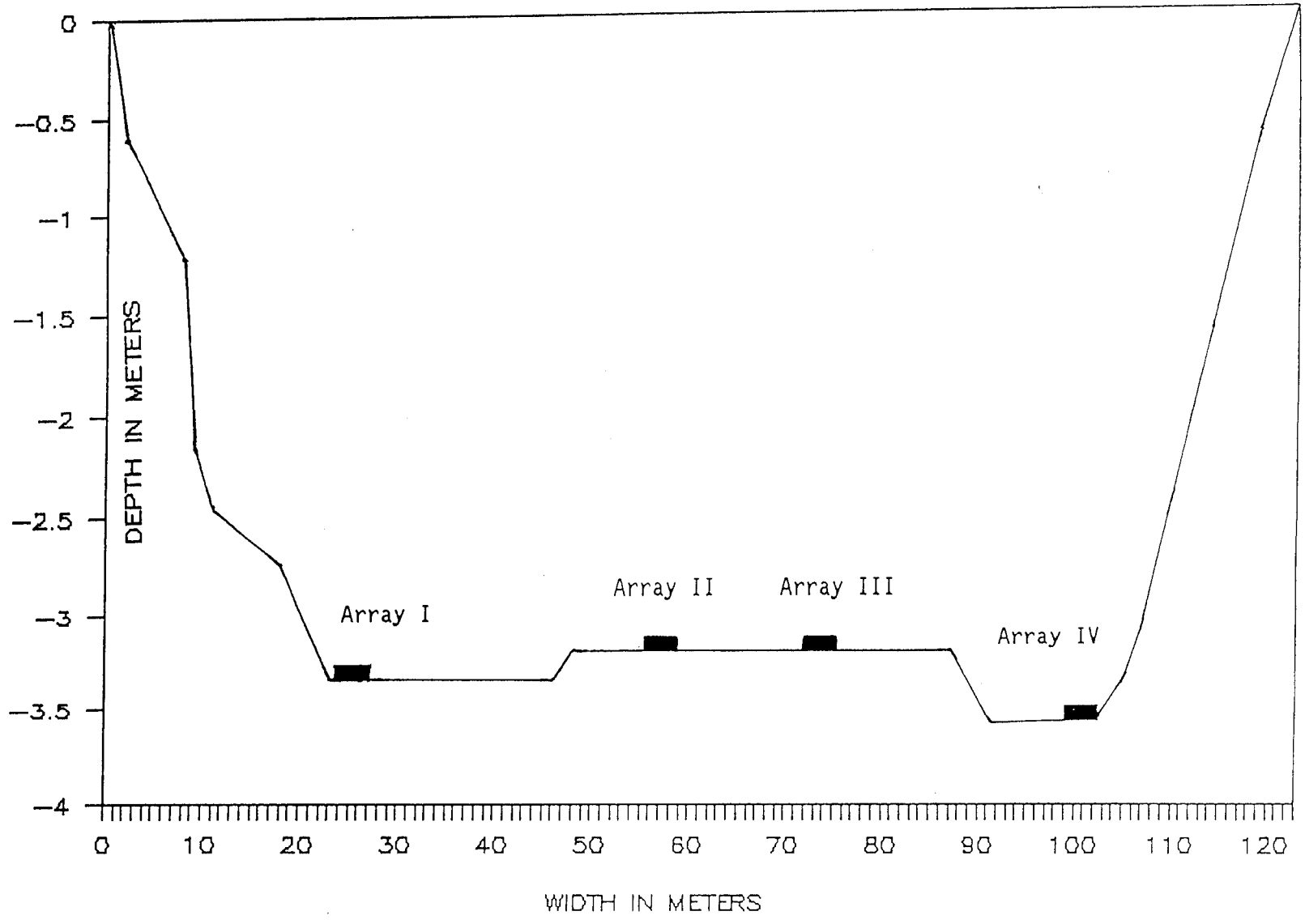
The counting site on the Kvichak River for 1989 was moved approximately one kilometer downstream from the site used for the previous 15 years. The former site was considered unusable because it was located on an island and side channels had become deep enough to allow smolt passage. The counting site was moved to lessen the possibility that smolt would be migrating though areas not covered by hydroacoustic equipment.

The river at the new site was deeper than the previously used site, necessitating a change in the smolt counting equipment. The equipment used to count smolt on the Kvichak River in 1989 (Appendix A.1) included: (1) a smolt counter located on the east bank which monitored three arrays and is described in the "METHODS" section of this report; and (2) a smolt counter located on the west bank which monitored one array and had previously been used on the Kvichak River (Woolington 1990).

Numbers of smolt migrating seaward were estimated by expanding the counts from the three east bank arrays across the entire river (Appendix A.2), as described earlier in the "METHODS" section. In addition, another estimate of seaward migrating smolt was calculated by using counts from all four arrays and expanding them across the river (Appendix A.3). The methods used to expand counts from the four arrays were the same as those described in the "METHODS" section, with the exception that biomass per count (BPC) recorded by the west bank counter from the fourth array equaled 83.0 g per count instead of 41.5 g. Thus counts from the fourth array were multiplied by two to be comparable to counts from the three east bank arrays.

The smolt migration estimate derived from expansion of the three east bank arrays (147,903,453) was amazingly similar to that derived from expansion of all four arrays (147,163,948). This was because the biomass estimated from counts recorded from the fourth array approximated the biomass estimated by linearly expanding counts from the third array to the offshore limit of smolt passage.

Because the west bank counter was not continuously monitored by our personnel for false counts, and because the smolt estimate was not changed significantly by including the counts from the fourth array, only counts from the three east bank arrays were used in the final estimate of smolt migration from the Kvichak River in 1989.




Appendix A.1 Bottom profile and location of transducer arrays at sockeye salmon smolt counting site, Kvichak River, 1989.

Appendix A.2. Daily number of sockeye salmon smolt migrating seaward, estimated from counts over three transducer arrays and expanded across entire river, Kvichak River, Alaska, 1989.

| | Age I | | | Age II | | | Age III | | | All Ages | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 5 28 | 1,369,874 | 97.7 | 1,369,874 | 32,535 | 2.3 | 32,535 | 0 | 0.0 | 0 | 1,402,409 | 1,402,409 |
| 5 29 | 24,127,127 | 97.7 | 25,497,001 | 573,043 | 2.3 | 605,578 | 0 | 0.0 | 0 | 24,700,170 | 26,102,579 |
| 5 30 | 5,572,981 | 90.8 | 31,069,982 | 557,605 | 9.1 | 1,163,183 | 10,439 | 0.2 | 10,439 | 6,141,025 | 32,243,604 |
| 5 31 | 10,626,486 | 90.8 | 41,696,468 | 1,063,234 | 9.1 | 2,226,417 | 19,906 | 0.2 | 30,345 | 11,709,626 | 43,953,230 |
| 6 01 | 3,355,989 | 86.2 | 45,052,457 | 539,529 | 13.9 | 2,765,946 | 0 | 0.0 | 30,345 | 3,895,518 | 47,848,748 |
| 6 02 | 7,070,439 | 86.2 | 52,122,896 | 1,136,687 | 13.9 | 3,902,633 | 0 | 0.0 | 30,345 | 8,207,126 | 56,055,874 |
| 6 03 | 24,708,053 | 93.9 | 76,830,949 | 1,610,708 | 6.1 | 5,513,341 | 0 | 0.0 | 30,345 | 26,318,761 | 82,374,635 |
| 6 04 | 17,527,758 | 99.2 | 94,358,707 | 134,231 | 0.8 | 5,647,572 | 0 | 0.0 | 30,345 | 17,661,989 | 100,036,624 |
| 6 05 | 1,725,111 | 99.3 | 96,083,818 | 12,860 | 0.7 | 5,660,432 | 0 | 0.0 | 30,345 | 1,737,971 | 101,774,595 |
| 6 06 | 12,753,080 | 99.3 | 108,836,898 | 95,076 | 0.7 | 5,755,508 | 0 | 0.0 | 30,345 | 12,848,156 | 114,622,751 |
| 6 07 | 1,000,175 | 97.2 | 109,837,073 | 28,917 | 2.8 | 5,784,425 | 0 | 0.0 | 30,345 | 1,029,092 | 115,651,843 |
| 6 08 | 2,729,315 | 97.2 | 112,566,388 | 78,911 | 2.8 | 5,863,336 | 0 | 0.0 | 30,345 | 2,808,226 | 118,460,069 |
| 6 09 | 12,840,315 | 99.5 | 125,406,703 | 63,227 | 0.5 | 5,926,563 | 0 | 0.0 | 30,345 | 12,903,542 | 131,363,611 |
| 6 10 | 3,192,198 | 98.1 | 128,598,901 | 61,163 | 1.9 | 5,987,726 | 0 | 0.0 | 30,345 | 3,253,361 | 134,616,972 |
| 6 11 | 4,945,408 | 99.5 | 133,544,309 | 25,850 | 0.5 | 6,013,576 | 0 | 0.0 | 30,345 | 4,971,258 | 139,588,230 |
| 6 12 | 3,275,571 | 99.2 | 136,819,880 | 26,415 | 0.8 | 6,039,991 | 0 | 0.0 | 30,345 | 3,301,986 | 142,890,216 |
| 6 13 | 1,536,181 | 99.2 | 138,356,061 | 12,388 | 0.8 | 6,052,379 | 0 | 0.0 | 30,345 | 1,548,569 | 144,438,785 |
| 6 14 | 2,537,152 | 99.2 | 140,893,213 | 20,460 | 0.8 | 6,072,839 | 0 | 0.0 | 30,345 | 2,557,612 | 146,996,397 |
| 6 15 | 899,800 | 99.2 | 141,793,013 | 7,256 | 0.8 | 6,080,095 | 0 | 0.0 | 30,345 | 907,056 | 147,903,453 |
| | 141,793,013 | 95.9 | | 6,080,095 | 4.1 | | 30,345 | 0.02 | | 147,903,453 | |

Appendix A.3. Daily number of sockeye salmon smolt migrating seaward, estimated from counts over four arrays and expanded across entire river, Kvichak River, 1989.

| | Age I | | | Age II | | | Age III | | | All Ages | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Number | Percent | Cumulative Total | Daily Total | Cumulative Total |
| 5 28 | 1,181,005 | 97.7 | 1,181,005 | 28,050 | 2.3 | 28,050 | 0 | 0.0 | 0 | 1,209,055 | 1,209,055 |
| 5 29 | 20,598,459 | 97.7 | 21,779,464 | 489,234 | 2.3 | 517,284 | 0 | 0.0 | 0 | 21,087,693 | 22,296,748 |
| 5 30 | 5,711,971 | 90.8 | 27,491,435 | 571,511 | 9.1 | 1,088,795 | 10,700 | 0.2 | 10,700 | 6,294,182 | 28,590,930 |
| 5 31 | 9,800,171 | 90.8 | 37,291,606 | 980,557 | 9.1 | 2,069,352 | 18,358 | 0.2 | 29,058 | 10,799,086 | 39,390,016 |
| 6 01 | 5,554,693 | 86.2 | 42,846,299 | 893,006 | 13.9 | 2,962,358 | 0 | 0.0 | 29,058 | 6,447,699 | 45,837,715 |
| 6 02 | 6,560,287 | 86.2 | 49,406,586 | 1,054,671 | 13.9 | 4,017,029 | 0 | 0.0 | 29,058 | 7,614,958 | 53,452,673 |
| 6 03 | 23,599,002 | 93.9 | 73,005,588 | 1,538,409 | 6.1 | 5,555,438 | 0 | 0.0 | 29,058 | 25,137,411 | 78,590,084 |
| 6 04 | 16,182,105 | 99.2 | 89,187,693 | 123,925 | 0.8 | 5,679,363 | 0 | 0.0 | 29,058 | 16,306,030 | 94,896,114 |
| 6 05 | 3,550,562 | 99.3 | 92,738,255 | 26,470 | 0.7 | 5,705,833 | 0 | 0.0 | 29,058 | 3,577,032 | 98,473,146 |
| 6 06 | 12,597,980 | 99.3 | 105,336,235 | 93,920 | 0.7 | 5,799,753 | 0 | 0.0 | 29,058 | 12,691,900 | 111,165,046 |
| 6 07 | 965,693 | 97.2 | 106,301,928 | 27,920 | 2.8 | 5,827,673 | 0 | 0.0 | 29,058 | 993,613 | 112,158,659 |
| 6 08 | 2,886,328 | 97.2 | 109,188,256 | 83,450 | 2.8 | 5,911,123 | 0 | 0.0 | 29,058 | 2,969,778 | 115,128,437 |
| 6 09 | 13,234,803 | 99.5 | 122,423,059 | 65,169 | 0.5 | 5,976,292 | 0 | 0.0 | 29,058 | 13,299,972 | 128,428,409 |
| 6 10 | 3,368,021 | 98.1 | 125,791,080 | 64,532 | 1.9 | 6,040,824 | 0 | 0.0 | 29,058 | 3,432,553 | 131,860,962 |
| 6 11 | 5,446,606 | 99.5 | 131,237,686 | 28,470 | 0.5 | 6,069,294 | 0 | 0.0 | 29,058 | 5,475,076 | 137,336,038 |
| 6 12 | 3,770,519 | 99.2 | 135,008,205 | 30,407 | 0.8 | 6,099,701 | 0 | 0.0 | 29,058 | 3,800,926 | 141,136,964 |
| 6 13 | 1,609,212 | 99.2 | 136,617,417 | 12,977 | 0.8 | 6,112,678 | 0 | 0.0 | 29,058 | 1,622,189 | 142,759,153 |
| 6 14 | 2,867,943 | 99.2 | 139,485,360 | 23,128 | 0.8 | 6,135,806 | 0 | 0.0 | 29,058 | 2,891,071 | 145,650,224 |
| 6 15 | 1,501,615 | 99.2 | 140,986,975 | 12,109 | 0.8 | 6,147,915 | 0 | 0.0 | 29,058 | 1,513,724 | 147,163,948 |
| | 140,986,975 | 95.8 | | 6,147,915 | 4.2 | | 29,058 | 0.02 | | 147,163,948 | |