BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES FOR 1994

by

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and

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Regional Information Report[1] No. 2A95-12

Alaska Department of Fish and Game
Division of Commercial Fisheries Management and Development
Regional Office
333 Raspberry Road
Anchorage, Alaska 99518-1599

April 1995

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[1]Contribution 95-12 from the Anchorage regional office. The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate needs for up-to-date information, reports in this series may contain preliminary data.

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ACKNOWLEDGMENTS

We wish to thank the following Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development personnel for contributing to the success of the Bristol Bay sockeye salmon smolt studies in 1994. Jane Browning[a], Debbie Crouch[b], Dan Gray[a] , Sally Hamm[c], Tom Kerns[d], John Levno-Chythlook[b], Bob McFadden[b], Susan McNeil[be], Don Perrin[c], Dan Salmon[ce], Fred Tilly [de], and Clyde Vicary[ae] collected smolt data. Cathy Tilly and Deborah Crouch aged all the smolt scales. Richard Russell provided supervisory assistance and support. Editorial reviews of this document were provided by Jim Miller and Richard Russell. We also wish to thank the following individuals for their contributions to the 1994 smolt studies. Hydroacoustics consultant, Al Menin provided technical assistance and expert advise. National Park Service technician, Paul Gibson, and student volunteers, Sarah Stuart and Jon Wangsness, assisted with logistics and data collection at the Naknek River smolt project. Fishery volunteer, Ronn Perrin, assisted with camp setup and logistics at the Kvichak River smolt project.

[a] Ugashik River Smolt Project
[b] Egegik River Smolt Project
[c] Kvichak River Smolt Project
[d] Naknek River Smolt Project
[e] Crew leaders.

PROJECT SPONSORSHIP

The Naknek River smolt project was financed through a cooperative agreement (COOP-93-050) between the Department of Interior, National Park Service, Katmai National Park and Preserve and the State of Alaska, Department of Fish and Game, Division of Commercial Fisheries Management and Development.

The Ugashik River smolt project was financed through a cooperative agreement (COOP-94-068) between the Lake and Peninsula Borough and the State of Alaska, Department of Fish and Game, Division of Commercial Fisheries Management and Development.

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ABSTRACT

Numbers of sockeye salmon *Oncorhynchus nerka* smolt emigrating to sea from four rivers in Bristol Bay, Alaska, were estimated from sonar counts and age-weight-length samples in 1994. Hydroacoustic equipment was used to estimate total smolt biomass, and age-weight-length samples were used to convert biomass estimates into numbers of smolt by age group. Estimated numbers of smolt emigrating were 83,845,472 from Kvichak River, 74,937,354 from Naknek River, 94,086,989 from Egegik River, and 30,030,624 from Ugashik River. Age-1. smolt, the progeny of 1992 spawners, predominated at Kvichak River (64.0%), Egegik River (58.4%), and Ugashik River (80.9%). Age-2. smolt, the progeny of 1991 spawners, predominated at Naknek River (56.5%).

KEYWORDS: smolt, sockeye salmon, *Onchorhynchus nerka*, smolt emigration, sonar, vertical distribution of passage, Bristol Bay, Kvichak River, Naknek River, Egegik River, Ugashik 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. From 1985 to 1994 the commercial catch in Bristol Bay averaged 26.6 million sockeye salmon (R.B. Russell, ADF&G, King Salmon, personal communication). To effectively manage this fishery, managers need accurate abundance forecasts of returning sockeye salmon to determine optimum spawning escapement goals. Estimates of outmigrating smolt numbers are currently used as an index of production for adult salmon; this improves the accuracy of preseason forecasts and aids in setting goals for optimum numbers of spawners.

Fyke nets were used to estimate smolt numbers on Kvichak River from 1956 to 1970; on Naknek River from 1956 to 1978; on Egegik River during 1957, 1969, and 1978; on Ugashik River from 1955 to 1965, 1967 to 1970, and 1972 to 1975; and on Wood River from 1955 to 1966 (Burgner and Koo 1954; Rietze and Spangler 1958; Kerns 1961; Burgner 1962; Jaenicke 1963, 1968; Church 1963; Church and Nelson 1963; Nelson 1964, 1965a, 1965b, 1966a, 1966b, 1969; Marriott 1965; Nelson and Jaenicke 1965; Pennoyer and Seibel 1965; Pennoyer 1966; Pennoyer and Stewart 1967, 1969; Robertson 1967; Siedelman 1967, 1969; Paulus and McCurdy 1969, 1972; Van Valin 1969a, 1969b; Shroeder 1972a, 1972b, 1974a; McCurdy and Paulus 1972a, 1972b; Paulus 1972; McCurdy 1974a, 1974b; Bill 1975, 1976, 1977; Pella and Jaenicke 1978; Yuen 1978). Although fyke net sampling provided information on age, size, and relative abundance of smolt, it did not provide an accurate estimate of total smolt numbers. To improve estimates of smolt numbers, the department began experimenting with and using hydroacoustic equipment.

Hydroacoustic equipment was used to estimate sockeye salmon smolt numbers on Kvichak River from 1971 through 1994; Wood River from 1975 to 1990; Naknek River from 1982 to 1986 and 1993 to 1994; Egegik River from 1982 through 1994; Ugashik River from 1983 to 1991 and 1993 to 1994; Nuyakuk River from 1983 to 1989; and Togiak River in 1988 (Russell 1972; Parker 1974a, 1974b; Krasnowski 1975; Randall 1976, 1977, 1978; Newcome 1978; Yuen 1980a, 1980b, 1982; Clark and Robertson 1980; Bucher 1980, 1981, 1982, 1983, 1984, 1986a, 1986b, 1987; Bergstrom and Yuen 1981; Yuen and Wise 1982; Eggers and Yuen 1984; Bue 1986a, 1986b; Bue and Fried 1987; Bue et al. 1988; Cross et al. 1990; Woolington et al. 1990, 1991; Crawford et al. 1992; Crawford and Cross 1992, 1994a, 1994b).

Hydroacoustic equipment developed by Bendix Corporation[2] was tested on Kvichak River in 1969 (McCurdy and Paulus 1972b; Paulus and Parker 1974). Further testing and modification of this prototype resulted in the construction of smolt counters for use on Wood (Krasnowski 1976, 1977) and Kvichak Rivers (Randall 1977) in 1975 and 1976. Hydroacoustic equipment

[2] Use of a company's name does not constitute endorsement.

for counting smolt was tested on Ugashik River from 1973 to 1975 (Schroeder 1974b, 1975; Sanders 1976). Smolt studies on Naknek, Egegik, Ugashik, and Nuyakuk Rivers were limited to occasional fyke net sampling to obtain age and size data from 1975 to 1982 (Huttunen 1980; Eggers 1984; Minard 1984). An experimental two-array sonar system similar to the one used on Kvichak River was tested on Egegik River during 1981 (Bue 1982). Smolt enumeration projects using modified counters began on Naknek and Egegik Rivers in 1982 (Huttunen 1984; Bue 1984) and on Ugashik and Nuyakuk Rivers in 1983 (Fried et al. 1987; Minard and Frederickson 1987).

Side-scanning sonar was used in 1985 and 1986 to determine the lateral distribution of smolt passing each of the respective sonar sites. Bue et al. (1988) reported that most smolt passing the Kvichak River sonar site stayed within a 68-m corridor that began 6.4 m from the left bank[3] (total river width = 100 m). Smolt passing the Egegik River sonar primarily used a 73-m corridor beginning 12.2 m from the left bank (total river width = 104 m). Ugashik River smolt used a 21-m corridor which began 7.0 m from the left bank (total river width = 43 m). Side-scanning sonar was not an effective tool for collecting lateral smolt distribution data on Wood River (Cross et al. 1990; Woolington et al. 1990, 1991). Therefore, lateral smolt distribution was assumed to be a function of river width and depth, measured and recorded when tidal influence was minimal. Based on those measurements, Wood River smolt were assumed to migrate within a 94-m corridor which began 3.3 m from the left bank.

Due to budget cuts, the monitoring of smolt migrations was discontinued on Naknek River in 1986 (Bue et al. 1988), on Togiak River in 1988 (Woolington et al. 1990), on Nuyakuk River in 1989 (Woolington et al. 1991), on Wood River in 1990 (Crawford et al. 1992), and on Ugashik River in 1992 (Crawford and Cross 1992).

In 1990 a single narrow-beam, side-looking sonar unit was used from May 29 to 31 to determine the lateral limits of smolt distribution at the Kvichak River sonar site (Huttunen and Skvorc 1991); most smolt migrated between 40 and 100 m offshore from the right bank. The total river width at the site was 136 m.

The results of the 1990 study were encouraging, so in 1991 it was expanded to evaluate the feasibility of using side-looking sonar to enumerate outmigrating Kvichak River sockeye salmon smolt. Huttunen and Skvorc (1992) estimated, based on 81 h of horizontal-aspect echo-integration data collected June 2-14, that 44,972,864 smolt passed through the sonar site during the counting period. This compared well to an upward-looking sonar estimate of 43,525,980 smolt for the same hours of operation. The maximum single-beam listening range for the side-looking sonar varied from 118 m to 120 m, ensonifying 88%-90% of the total 134-m river cross section. In comparison, the three arrays of the historical upward-looking sonar ensonified roughly 7.5% of the river. The spacial distribution of smolt on a nightly basis were highly dynamic; side-looking estimates peaked at ranges from 64 m on June 12 to 118 m on June 7. Whereas the distribution of upward-looking estimates also varied between nights, the largest

[3] In this report the location of projects and the placement of equipment are referenced to the right and left bank of the respective river as determined by facing downstream at the study site.

estimates were typically from the inshore array at 56 m from the right bank. No side-looking sonar smolt studies have been conducted since 1991 due to lack of funding.

In 1993, approval of a cooperative agreement between the National Park Service and the Alaska Department of Fish and Game (ADF&G) allowed for continued enumeration of sockeye salmon smolt with hydroacoustic equipment on Naknek River in 1993 and 1994. The primary impetus for resuming the Naknek River smolt study was to measure freshwater production from the record sockeye salmon escapement (3.6 million fish) that entered the Naknek River drainage to spawn during the 1991 commercial fishermen strike. The 1991 escapement was the largest escapement on record and was 40% greater than the previous high of 2.6 million. Both agencies deemed it important to measure the number of smolt surviving freshwater residency and the size and age structure of smolt from an escapement of this size. Most sockeye salmon smolt from the 1991 brood year were expected to outmigrate from the Naknek River drainage as age-1. smolt in 1993 and as age-2. smolt in 1994.

Approval of a cooperative agreements between the City of Pilot Point and ADF&G in 1993 and the Lake and Peninsula Borough and ADF&G in 1994 allowed for continued enumeration of sockeye salmon smolt with hydroacoustic equipment on Ugashik River. The Ugashik River smolt study was resumed to measure the freshwater production and the size and age structure of smolt from the 1990 (730 thousand fish), 1991 (2.4 million fish), and 1992 (2.2 million fish) sockeye salmon spawning escapements. Also each of these organizations wanted a continuation of the 9-year data base that had been collected annually for Ugashik River sockeye salmon smolt from 1983 to 1991. Sockeye salmon smolt expected to outmigrate from the Ugashik River drainage in 1993 are age-1. smolt from the 1991 brood year and age-2. smolt from the 1990 brood year. Sockeye salmon smolt expected to outmigrate from the Ugashik River drainage in 1994 are age-1. smolt from the 1992 brood year and age-2. smolt from the 1991 brood year.

Upward-looking sonar studies were conducted on Kvichak, Naknek, Egegik, and Ugashik Rivers in 1994 to: (1) estimate numbers of outmigrating sockeye salmon smolt; (2) describe smolt migration patterns; (3) collect smolt age, weight, and length data; and (4) record climatological and hydrological parameters which might affect migratory behavior.

METHODS

Hydroacoustic Equipment

Bendix Corporation constructed all hydroacoustic systems used to estimate smolt numbers in Bristol Bay river systems in 1994; all projects used 1982 or 1983 model smolt counters. Transducers used to transmit and receive sound pulses at each sonar site were housed in two-to-three 3.03-m long arrays set on the river bottom and connected by coaxial cable to a control unit located on shore. Three arrays were used at each sonar site except Ugashik River. Only two arrays were used at Ugashik River due to a narrower channel width. Each array had 10 upward-

facing single-element International Transducer Corporation, Model 5095 transducers which were designed to operate at a frequency of 235 Khz and a half power beamwidth angle of 9°. Detected echoes from each transducer were accumulated in the smolt counter and a printer produced a hard copy of totaled counts by array at prescribed intervals which were summed and recorded on a field data collection form hourly. Each smolt counting system was powered by a single 12-volt battery recharged by a pair of 43 watt, 2.9 amp solar panels.

Hydroacoustic equipment to monitor smolt outmigrations was operated on Kvichak, Naknek, Egegik, and Ugashik Rivers from mid-May to mid-June. The smolt outmigrations in Kvichak, Egegik, and Ugashik Rivers generally peak during late May or early June and drop off by mid-June. On Naknek River, the peak smolt outmigration is less pronounced and more prolonged, therefore the hydroacoustic equipment was operated a few days longer. All arrays at each project site were removed from the water at the end of the field season.

All hydroacoustic systems used in 1994 were factory calibrated to record one count whenever 41.5 g of biomass passed through each transducer beam during a given period. Because most smolt migrate within the upper portion of the water column, individual arrays were calibrated independently, which allowed the operator to set the counting range as near the surface as possible. The equipment was set to record counts to within 1-2 cm of the water surface to avoid counting debris or entrapped air.

Sources of false counts, e.g., boats, wind, rain, debris, were noted and the hydroacoustic equipment was disabled whenever 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. The control unit automatically recorded and stored the length of time the system was disabled. Manual control was available 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. The Kvichak, Naknek, and Egegik River smolt counters each monitored three transducer arrays. The Ugashik River smolt counter monitored two transducer arrays.

In 1989, the Kvichak River smolt counting system was relocated and modified so that one smolt counter on the right bank monitored three arrays and a second smolt counter on the left bank monitored a fourth array to account for the greater river width and depth at the new site. Analysis of the 1989 data (Woolington et al. 1991) revealed no advantages to using a three- versus four-array system; therefore, in 1990 only three arrays and one counter were used. The offshore transducer cables were also extended 100 ft to help enumerate smolt in the deep, fast water near the left bank. In addition, Al Menin of Bendix Corporation modified the Kvichak counter in 1989 and 1990 to enable counting in the deeper water at the new site. As a result of these changes, a new depth setting factor of 1.79 and a new formula, Water Depth = (Depth Setting * 1.79) + 3.0 ft, were introduced in 1990 to convert depth settings on the smolt counter to actual river depths. The additional 3.0 ft is an electronic blanking range that is built into the Kvichak River counter to account for near-field effects. For a detailed discussion of near-field effects, refer to MacLennan and Simmonds (1992).

Between the 1992 and 1993 field seasons, several hydroacoustic equipment changes were made. Due to uncorrectable problems with the modified Kvichak counter's Practical Automation, Inc., Model C4-265 moduprint printer, use of this counter and its seven-transducer-per-array system

was discontinued after 1992. In 1993 the modified Kvichak counter (Bendix, 1976 model) and arrays were replaced by a Bendix, 1982 model counter with three 10-transducer arrays which had been used on the Naknek River from 1982 to 1986. Prior to the field season, sonar consultant Al Menin, extended each of the ten offshore array cables (standard width = 330 ft) an additional 85 ft for use at the wider Kvichak River site in 1993 and he also installed 10 new 150 Uh inductors in the offshore array components of the smolt counter to tune them for the additional cable length. A Bendix, 1982 model smolt counter with three 10-transducer arrays was also used at Naknek River smolt in 1993. This unit had originally been used on Nuyakuk River from 1983 to 1989. Therefore since 1993, all smolt projects have used 1982 or 1983 model smolt counters with 10-transducer arrays.

In 1994, Al Menin added a three-way switch to the Ugashik River smolt counter which enable the operator to select shorter printout intervals (e.g., 1.875 printouts per minute or 3.750 printouts per minute) when the smolt are running strong.

Project Locations

The 1994 Kvichak River counting site was located 6 km below the outlet of Lake Iliamna (Figure 1); it was moved to this location in 1989, approximately 1 km downstream from the site used during the previous 15 years (Woolington et al. 1991). The Kvichak River was 134 m wide at this site. Three transducer arrays referred to as *inshore, center,* and *offshore*, were anchored 58 m, 70 m, and 91 m from the right bank (Figure 2). Array placement was improved by using lateral smolt distribution data reported by Huttunen and Skvorc (1991, 1992).

The Naknek River counting site was located 13 km below the outlet of Naknek Lake (Figure 1); this is the same location that it was operated during 1982 to 1986 and 1993. The inshore, center, and offshore arrays were anchored 31 m, 47 m, and 63 m from the left bank (Figure 3). Naknek River is 107 m wide at this site.

The Egegik River counting site was located 4 km below the outlet of Becharof Lake (Figure 1); it has been operated at this location since 1982 (Eggers and Yuen 1984). Egegik River is 112 m wide at this site. The inshore, center, and offshore arrays were anchored 40 m, 55 m, and 67 m from the left bank (Figure 4).

The Ugashik River counting site was located 50 m below the outlet of Lower Ugashik Lake (Figure 1). Because this river-section is only 43 m wide, only two arrays have been used. The inshore and offshore arrays were anchored 27 m and 32 m from the right bank (Figure 5).

Estimation of Smolt Numbers

The process of estimating smolt numbers was divided into three steps: (1) determining total fish biomass emigrating past the study site; (2) sampling the emigrating 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 using continually monitored hydroacoustic equipment. The signal pulse rate of the smolt counter was set to correspond with the river velocity measured at a location referred to as the *velocity index*. In most instances, the velocity at one of the arrays was used as the velocity index. At Naknek River, a buoyed flow meter anchored downriver of the inshore array was used as the velocity index.

Estimation of River Velocities and Adjustments to Sonar Counts. River velocities at the Kvichak and Ugashik River sites were nearly constant; thus velocities were measured once a week with a Gurley[3], Model 622 flow meter and the counter was adjusted accordingly.

River velocities at the Naknek and Egegik River sites were influenced by tides, therefore river velocities were measured continuously by a Gurley, Model 622 or Model 625 flow meter anchored directly behind the velocity index array, and smolt counts were adjusted every 15-30 min to account for changes in river velocity. To account for differences in river velocities between the velocity index and the arrays (i) readings over each array were taken at specified intervals and velocity correction factors (vcf_i) were then calculated:

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

where

v_i = velocity over array i, and
v_{index} = velocity over the velocity index array.

Using these correction factors, adjustments to daily counts ($ac_{i,z}$) were made for differences in river velocity:

$$ac_{i,z} = c_{i,z}(vcf_i), \qquad 2$$

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

Ideally, all sonar arrays monitored fish biomass 24 h/d, so daily counts for each array represented actual sonar counts. If an array was not monitored during an hour, counts were linearly interpolated using estimated counts from the previous and following hours.

Expansion of Biomass Estimates. The width of the section of river ($l_{i,z}$) monitored by array i on day z depended on array length (3.03 m), water depth over the array, and transducer signal beam width:

$$l_{i,z} = 3.03 + 2\left(d_{i,z} \tan\frac{bw}{2}\right) , \qquad 3$$

where

$d_{i,z}$ = 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; distances from each array to a reference point on one river bank were measured to the nearest foot. Estimates of the inshore and offshore limits of smolt passage were made based on past studies with side-scanning hydroacoustic equipment (Bue et al. 1988; Huttunen and Skvorc 1991, 1992). Distances were calculated between inshore limit of smolt passage to first array (D_1); first to second array (D_2); second to third array (D_3) at sites where three arrays were used; and offshore array to offshore limit of smolt passage (D_4).

The estimated biomass of fish ($\hat{B}_z$) passing the counting site on day z was calculated as follows:

$$\hat{B}_z = \frac{1}{2}D_1\left(\frac{ac_{1,z}}{l_{1,z}}\right) + \sum_{i=2}^{na}\left[\frac{1}{2}D_i\left(\frac{ac_{i-1,z}}{l_{i-1,z}} + \frac{ac_{i,z}}{l_{i,z}}\right) + \frac{1}{2}D_{na+1}\left(\frac{ac_{na,z}}{l_{na,z}}\right)\right] , \qquad 4$$

where

D_i = the distance for interval i, and
na = number of transducer arrays used.

Age, Weight, and Length Estimation

Data on age, weight, and length of sockeye smolt were obtained from samples captured in a fyke net. Smolt weight in grams and length, from tip-of-snout to fork-of-tail, in millimeters were measured; age was determined from visual observations of scales mounted on glass slides. European ages -- 1., 2., or 3. depending on the number of freshwater annuli -- were used. Parent year escapements that produced 1994 smolt occurred in 1992 for age-1. smolt, 1991 for age-2. smolt, and 1990 for age-3. smolt.

Sample size goals for Kvichak, Naknek, Egegik, and Ugashik Rivers were 400 smolt/d. Based on binomial proportions for the two major age groups, a sample size of 400 smolt would simultaneously estimate the percentage of each age class within 5% of the true percentage 95% of the time (Goodman 1965; Cochran 1977). When the daily goal of 400 smolt was not obtained, samples from subsequent days were combined until a total of at least 400 was reached.

Mean length of smolt differs among fyke net samples from a single day (Minard and Brandt 1986). Thus, to ensure that daily age composition estimates were representative of the population, attempts were made daily to obtain 100 smolt from each of six different fyke net catches. Because weight and age of smolt are strongly correlated to length, the time and cost of data collection was reduced by measuring all smolt collected each day: up to a maximum of 600 for length and weighing and sampling up to 100 of those smolt for age (Bue and Eggers 1989).

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, we estimated weights (W_j) of age j smolt measured only for length as explained by (Ricker 1975):

$$W_j = \alpha L_j^{\beta} \quad , \qquad 5$$

where

L_j = fork length of an age j smolt, and
α and β = parameters which determine the y-axis intercept and the slope of the line.

Age was estimated for smolt measured only for length using an age-length key (Bue and Eggers 1989). The key used length to categorize age-1. or -2. sockeye salmon smolt by determining a discriminant length that minimized classification error. This discriminant length was chosen such that the number of age-1. smolt classified as age-2. smolt was equal to the number of age-2. smolt classified as age-1. smolt. Age-3 smolt were not included in this analysis because to few samples were collected.

Due to the variability of age and size composition estimates among subsamples (e.g., fyke net catches) taken the same day, daily mean weight ($\hat{W}$) and age proportions ($\hat{P}_j$) were estimated as the mean of subsampled values:

$$\hat{W} = \frac{\sum_{k=1}^{m} \left(\frac{\sum w_k}{n_k} \right)}{m} \quad , \qquad 6$$

where

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

$$\hat{P}_j = \frac{\sum_{k=1}^{m}\left(\frac{n_{j,k}}{n_k}\right)}{m} \quad , \qquad 7$$

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

Estimation of Smolt Numbers

Numbers of smolt by age $(\hat{SPC})$ 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:

$$\hat{SPC} = \frac{BPC}{\hat{W}} \quad , \qquad 8$$

where BPC = biomass (g) per count.

The estimated number of smolt passing the counting site $(\hat{N}_z)$ each day (z) was computed:

$$\hat{N}_z = \hat{B}_z \ (\hat{SPC}) \quad . \qquad 9$$

The estimated number $(\hat{N}_{j,z})$ of age j smolt on day z were then apportioned:

$$\hat{N}_{j,z} = \hat{N}_z(\hat{P}_j). \qquad 10$$

Finally, daily estimates of smolt numbers were summed: the seasonal total of all smolt passing the sonar site $(\hat{N}_{tot})$ was

$$\hat{N}_{tot} = \Sigma \hat{N}_z \qquad 11$$

and the estimated number of age j smolt that passed the site during the season ($\hat{N}_{jtot}$) was

$$\hat{N}_{jtot} = \Sigma \hat{N}_{j,z} \quad . \qquad 12$$

Vertical Distribution of Smolt Passage

Monitoring of vertical distribution of passing smolt schools was conducted with an oscilloscope during the 2 weeks of peak smolt passage. Vertical distribution of smolt was monitored for approximately 1 h during each 8-h shift. Observers recorded the top and bottom depth (in centimeters) of passing smolt schools and spread their hour of monitoring throughout their shift and among all arrays. The arrays that received the highest counts were monitored most.

Climatological Data Collection

Climatological data were recorded at each counting site. Observations of sky conditions and measurements of wind direction, wind velocity (kilometers/hour), daily precipitation (millimeters), air and water temperatures (° Centigrade) were recorded at 0800 and 2000 hours daily.

RESULTS

Kvichak River

A total of 2,162,194 sonar counts were recorded at the Kvichak River counting site from May 28 to June 15, 1994 (Table 1). More counts were recorded over the offshore array (40.2%) than over the inshore (34.8%) or center (25.0%) arrays (Figure 6). Daily sonar counts were highest from May 31 to June 9 when 76.7% of the total counts were recorded (Figures 7, 8). The peak daily sonar count of 345,331 occurred on June 5. Over the course of the entire sampling season, 37.5% of the total sonar counts were obtained between 2200 hours and 0400 hours (Figure 9); the remaining counts were spread fairly evenly throughout the day.

Locals residents reported that the ice on Lake Iliamna began to breakup on May 5 (R. Russell, ADF&G, King Salmon, personal communication). Although ADF&G's Kvichak Smolt personnel arrived in Igiugig on May 17, it was impossible to count smolt with sonar in the Kvichak River prior to May 28 due to continuous flows of lake ice in the river from Lake Iliamna's spring

breakup. The first observations of birds feeding successfully on smolt in Kvichak River occurred on May 20 at Igiugig (D. Salmon, ADF&G, Igiugig, personal communication). For the next 7-to-8 days, terns, gulls, and mergansers were seen feeding on smolt each morning and evening along gravel bars and islands of the river. On the morning of May 28 the ice flows in the river subsided enough that the crew was able to set their sonar arrays in the river. However subsequent ice flows damaged several center array cable connectors and the necessary repairs delayed the start up of the smolt sonar counter until 1800 hours on May 28. Therefore an undetermined number of smolt passed the Kvichak smolt counting site for 7-to-8 days before counting began. The first fyke net set fished from 1700 to 1730 hours on May 29 caught only 200 sockeye salmon smolt which indicated a relatively low abundance (CPUE=7) of smolt in the river. The age composition of this first fyke net catch was 60% age-2. and 40% age-1. smolt.

There were no additional problems with equipment or weather at Kvichak Smolt in 1994 that required the interpolation of sonar counts.

River velocity measurements over the center index array, which were used to adjust the sonar counter firing rate, ranged from 1.2 m/s to 1.4 m/s. Velocity correction factors (m/s) used for the three arrays were as follows:

Smolt Days	Inshore	Center	Offshore
May 28 - June 06	1.04	1.00	0.91
June 07 - June 11	1.03	1.00	0.93
June 12 - June 15	1.00	1.00	0.95

Based on sonar counts an estimated 83,845,472 sockeye salmon smolt migrated from Kvichak River in 1994 (Table 2). However, an undetermined portion of the front end of the outmigration passed the site prior to gear deployment and was not counted. Age-1. smolt (1992 brood year) composed 64.0% of the total migration. Age-2. smolt predominated on May 28-29, June 2 and June 5, however Age -1. smolt predominated thereafter and their percentage generally increased as the outmigration progressed (NSC = nonstatistical comparison). Mean weight of smolt also generally decreased (NSC) during the season, which resulted in an increase in the estimated number of smolt per count (Table 3). Total production from the 1990 spawning escapement of 6,970,020 sockeye salmon was 31.97 smolt per spawner (Table 4). The 1990 smolt production from Kvichak was 30% greater than the recent ten-year average; mean production from brood years 1980-1989 was 24.59 smolt per spawner. Marine survival (i.e. adult salmon returns per smolt) has averaged 13% for age-1. smolt for the 1978-1987 brood years and 16% for age-2. smolt for the 1978-1987 brood years (Table 5).

Age, weight, and length data were collected from 1,618 sockeye salmon smolt in 1994 (Table 6). All smolt sampled were age 1. or 2. Mean weight was 5.7 g for age-1. smolt and 9.5 g for age-2. smolt. Mean length was 84 mm for age-1. smolt and 102 mm for age-2. smolt. Age-1. and -2. smolt in 1994 were 4% to 5% shorter in length and 2% to 9% lighter in weight than the 1955-1993 average (Table 7). An additional 8,349 smolt were measured for length only (Table 8).

Fifty-four depth measurements were recorded for smolt schools passing over Kvichak River sonar arrays between May 28 and June 10 (Table 9). Schools passed at an average depth range of 30 cm to 180 cm below the surface. The water depth over the sonar arrays ranged from 307 cm to

337 cm during the peak smolt passage. Data, although limited, suggest that depth of smolt passage may have varied diurnally (Figure 10). During daylight, smolt schools tended to travel at greater depths below the surface than during darkness.

River and weather conditions were recorded at the counting site from May 22 to June 16 (Table 10). Extensive lake ice in the river prevented smolt counting with sonar prior to May 28, however the weather was good for smolt counting thereafter. The smolt counter was not disabled for any weather related reasons after it began counting on May 28. Mean water temperature during the project was 6.1° C (range 1.5° C to 11.0° C), which was warmer (NSC) than the 1963-1993 mean of 5.7° C (Table 11). Mean daily water temperature during the peak of the smolt migration was 6.0° C on June 5.

Naknek River

A total of 2,955,649 sonar counts were recorded at the Naknek River counting site from May 19 to June 19, 1994 (Table 12). More counts were recorded over the center array (42.3%) than over the offshore (37.2%) or inshore (20.5%) arrays (Figure 11). Daily sonar counts were highest from June 6-12 when 62.0% of the total counts were recorded (Figures 12, 13). The peak daily sonar count of 383,243 occurred on June 7. Similar high counts also occurred on June 8 (379,673) and June 9 (352,968). The fluctuation in daily sonar counts from June 15-19 indicate that some unknown number of smolt continued to emigrate from the Naknek River after June 19. Over the course of the sampling season, half of the total sonar counts were recorded from 2200 hours to 0600 hours (Figure 14); while the remainder of the counts were spread fairly evenly over the remaining hours.

Locals residents reported that Naknek Lake was 50% ice free by April 21 and completely ice free by May 4 (R. Russell, ADF&G, King Salmon, personal communication). No sockeye salmon smolt or signs of birds successfully feeding on smolt were reported prior to the start up of this project. The Naknek River smolt sonar began counting at 1200 hours on May 19 and the first reported smolt counts occurred at 1100 hours on May 20. Smolt counts obtained during the first three days of operation indicated low smolt abundance. A fyke net was first fished from 2000 hours to 2015 hours on May 20 and caught only 1 sockeye salmon smolt. Smolt passages fluctuated up and down between May 22 and June 4. On June 2, from 0850 hours to 1130 hour, a continuous band of smolt were observed passing the smolt site with the current just beneath the surface of the water about 12 m from the right bank (F. Tilly, ADF&G, King Salmon, personal communication). Some of these smolt passed over the offshore array, however it appeared that the majority passed beyond the offshore array. The winds were calm at the time and this was the only instance we observed a sizable number of smolt passing the sonar site beyond the range of our sonar. After June 4, the smolt outmigration began to build to a peak on June 7-9 and decreased steadily thereafter.

All offshore array sonar counts from 1700 hours May 22 to June 19 were multiplied by 1.11 to account for a bad transducers (#6). All center array sonar counts from 1200 hours May 31 to June 19 were multiplied by 1.11 to account for a bad transducer (#2). All inshore array sonar

counts from 1200 hours June 6 to June 19 were multiplied by 1.11 to account for a bad transducer (#7).

All arrays were interpolated for the following time and date: 2100 hours on May 29 due to high winds.

River velocity at the counting site ranged from 0.6 m/s to 1.1 m/s over the sonar arrays. From 1982 to 1986, the inshore array was used as the index array at this site. In 1993, continuous velocity measurements were taken from a flow meter that was attached to a buoy anchored 7 m to 9 m below the inshore array. Because of increased boat and aircraft traffic from a popular rainbow trout sport fishery that has developed in this reach of Naknek River it was necessary to position the continuous velocity meter out of the main flow of traffic. On May 29 we discovered that the velocity at the flow meter buoy was slower than the velocity at the inshore array and therefore the flow meter buoy was adopted as the index and the smolt counter was calibrated according to the water velocity at the index buoy for the remainder of the 1993 and the 1994 field season. Velocity correction factors (m/s) used for the three arrays were as follows:

Smolt Days	Index Buoy	Inshore	Center	Offshore
May 19-May 29	1.00	1.00	1.10	0.76
May 30-June 08	1.00	1.17	1.25	0.89
June 09-June 19	1.00	1.16	1.29	1.01

An estimated 74,937,354 sockeye salmon smolt migrated from the Naknek River in 1994 (Table 13). We believe that this smolt estimate constitutes the bulk of the 1994 Naknek River smolt outmigration, however the fluctuating daily sonar counts from June 15-19 (Figures 12, 13) indicate that some unknown portion of the tail end of this outmigration was not counted. Age-2. smolt (1991 brood year) composed 56.5% of the total migration. Although the daily percentage of age-1. and -2. smolt fluctuated during the 1994 migration, the percentage of age-2. smolt predominated on 21 out of 31 days that this project was operated and the percentage of age-2. smolt decreased over time (NSC = nonstatistical comparison). Mean weight of smolt remained high for much of the season (Table 14). The total production of age-1. and -2. smolts from the record 1991 spawning escapement of 3,578,508 sockeye salmon was 66,505,945 smolt (Table 15). Average marine survival, e.g. adult salmon returns per smolt, has averaged 6% for age-1. smolt for the 1980-1984 brood years and 7% for age-2. smolt for the 1979-1983 brood years (Table 16).

Age, weight, and length data were collected from 2,305 sockeye salmon smolt in 1994 (Table 17). All smolt sampled were age 1. or 2. Mean weights by age were 7.4 g for age-1. and 10.9 g for age-2. smolt. Mean lengths by age were 93 mm for age-1. and 107 mm for age-2. smolt. Age-1. and -2. smolt in 1994 were 5% to 6% shorter in length and 18% lighter in weight than the 1957-1986 plus 1993 average (Table 18). An additional 12,494 smolt were measured for length only (Table 19).

One hundred ninety-five depth measurements were recorded for smolt schools passing over Naknek River sonar arrays between May 20 and June 19 (Table 20). Most schools passed from 19 cm to 80 cm below the surface. The water depth over the sonar arrays ranged from 328 cm to 384 cm during the peak smolt passage. Data, although limited, suggest that depth of smolt

passage may have varied diurnally (Figure 15). Depth ranges of 0 cm to 107 cm for smolt schools during daylight (0600 hours to 2200 hours) tended to be greater than during darkness (2300 hours to 0500 hours) when depths were 5 cm to 180 cm.

River and weather conditions were recorded at the counting site from May 19 to June 20 (Table 21). There were no ice problems during the 1994 sampling season and the weather was generally good for smolt counting. The smolt counter was disabled for 1 h on May 29 because of waves produced by strong southerly winds. Mean water temperature during the project was 10.0° C (range 7.7° C to 15.0° C), which was slightly cooler (NSC) than the 1967-1986 plus 1993 mean of 11.0° C (Table 22). Mean daily water temperature during the peak of the smolt migration was 10.2° C on June 9.

Egegik River

A total of 6,277,738 sonar counts were recorded at the Egegik River counting site from May 21 to June 9, 1994 (Table 23). Sonar counts were fairly evenly distributed between all three arrays (Figure 16). Daily sonar counts were trimodal in 1994. The first movement of smolt occurred from May 21-28 (30.0%), the second from May 29 to June 1 (29.4%), and the third from June 2-9 (40.6%) (Figures 17, 18). The peak daily sonar count of 945,351 occurred on May 31. Over the course of the season, most sonar counts were recorded between 1800 hours and 0600 hours (Figure 19); 80.2% of all smolt counts were obtained during these times.

Local pilots reported that most of Becharof Lake was ice free by April 4 and that there was no signs of ice on the lake on April 21 (R. Russell, ADF&G, King Salmon, personal communication). No observations of smolt or birds feeding on smolt prior to the startup of the Egegik River smolt sonar counter at 0800 hours on May 21 (R. McFadden, ADF&G, Egegik River, personal communication). The first smolt catches (n=198) in the fyke net were made between 0141 hours and 0157 hours on May 22. The first distinguishable passage of smolt past the sonar was reported at 1530 hours on May 23.

River velocities at the counting site were 0.7-0.8 m/s over the center array. Historically, the inshore array has been used as the index array at this site. However, starting in 1992 the center array was used as the index array because the water velocity over the inshore array had decreased, and few smolt were passing over this array. In contrast, the water velocity at the center array was faster and more smolt were passing over it, therefore, the smolt counter has been calibrated according to the water velocities over the center array since then. Velocity correction factors (m/s) used for three arrays were:

Smolt Days	Inshore	Center	Offshore
May 21 - May 26	0.83	1.00	1.04
May 27 - Jun 01	0.82	1.00	1.10
Jun 02 - Jun 08	0.81	1.00	1.01
Jun 09	0.72	1.00	1.07

An estimated 94,086,989 sockeye salmon smolt migrated from Egegik River in 1994 based on sonar counts (Table 24). Age-1. smolt composed 58.4% of the total migration. The daily percentage of age-1. smolt ranged from 34.3% to 73.9% during the migration. Mean weight of smolt generally decreased over the season (Table 25), resulting in an increase in the estimated number of smolt per count (NSC). Total production from the 1990 spawning escapement of 2,191,362 sockeye salmon was 19.98 smolt per spawner (Table 26). The 1990 smolt production from Egegik was below average; mean production for brood years 1980-1989 was 53.83 smolt per spawner. The greatest smolt production was 106.84 smolt per spawner for the 1983 brood year. Average marine survival has been 25% for age-1. smolt for the 1980-1988 brood years and 26% for age-2. smolt for the 1979-1987 brood years (Table 27).

Age, weight, and length data were collected from 1,984 sockeye salmon smolt in 1994 (Table 28). Age-1., -2., and -3. smolt were sampled. Mean weight was 9.6 g for age-1., 13.7 g for age-2. smolt, and 14.6 g for age-3. smolt. Mean length was 104 mm for age-1. smolt, 118 mm for age-2. smolt, and 125 mm for age-3. smolt. In comparison to the 1939-1993 average, age-1. smolt were average in length and weight, age-2. smolt were average in length and 5% lighter, and age-3. smolt were average in length and 31% lighter (Table 29). An additional 9,408 smolt were measured for length only (Table 30).

One hundred twenty-one depth measurements were recorded for smolt schools passing over Egegik River sonar arrays during peak smolt passages between May 23 and June 07 (Table 31). Most schools passed from 61 cm to 217 cm below the surface. Water depth over the sonar arrays at this site ranged from 325 cm to 401 cm. Figure 20 shows the depth of smolt passage by hour for each array.

River and weather conditions were recorded at the counting site from May 21 to June 10 (Table 32). There were no problems with ice and there was very little down time for the Egegik River smolt sonar during 1994. The smolt counter was disabled for 1 h on May 27 and 2 h on June 09 to measure water velocities, for 2 h on May 31 due to solar panels overcharging the sonar counter, and for 1 h on June 3 to readjust the positioning of the sonar arrays. Mean water temperature during the season was 7.2° C (range 3.0° C to 9.0° C), which was slightly lower (NSC) than the 1981-1993 average of 6.2° C (Table 33). Mean daily water temperature during the peak of the smolt outmigration on May 31 was 5.8° C.

Ugashik River

A total of 3,241,509 sonar counts were recorded at the Ugashik River sonar counting site from May 20 to June 12, 1994 (Table 34). Most counts (72.7%) were recorded over the offshore array (Figure 21). Daily sonar counts were highest from May 31 to June 7 when 79.4% of the total counts were recorded (Figures 22, 23). The peak daily sonar count of 746,637 occurred on June 4. Over the entire sampling season, 88% of all smolt counts were obtained between 2100 hours and 0500 hours (Figure 24).

Local pilots reported that the ice on Upper and Lower Ugashik Lakes broke up by April 8 (R. Russell, ADF&G, King Salmon, personal communication). No smolt or signs of birds successfully

feeding on smolt were observed prior to the startup of this project. The smolt sonar counter was activated at 1630 hours on May 20. The first sockeye salmon smolt (n=150) were caught in the fyke net fished from 0100 hours to 0109 hours on May 22. The first reported push of smolt past the sonar counter occurred at 0100 hours on May 25.

By and large, the weather was favorable for enumerating sockeye salmon smolt emigrating from Upper and Lower Ugashik Lakes in 1994. However, wind and wave action produced by wind did inhibit smolt counting on May 26, May 28, and June 6-7. Forty-four hours of disabled time were adjusted by interpolation: 1500 hours on May 21 due to a sleet storm; 1700 hour, 0900 to 1100 hours on May 23 due to equipment modifications; 1800 hours May 25 to 0600 hours on May 26 due to entrained air from wave action; 1700 hours to 2000 hours on May 28 due to wind and rain; 1500 hours on May 30 due to heavy boat traffic; 1500 hours to 1600 hours on June 5, 0100 hours to 0500 hours, 0800 hours to 1100 hours on June 6 due to wind; and 1200 hours to 2200 hours on June 7 due to wave action. For comparison, the Ugashik River smolt counter was disabled on one or more arrays for 264 h in 1993 due to weather-related events and 162 h of these counts were able to be adjusted by interpolation.

River velocities measurements over the inshore index array ranged from 2.2 m/s to 2.4 m/s. Velocity correction factors (m/s) used to adjust the sonar counter firing rate for the two arrays were as follows:

Smolt Days	Inshore	Offshore
May 20 - May 25	1.00	0.98
May 26 - Jun 01	1.00	0.98
Jun 02 - Jun 07	1.00	1.00
Jun 08 - Jun 12	1.00	1.03

An estimated 30,030,624 sockeye salmon smolt migrated from Ugashik River in 1994 (Table 35). Age-1. smolt (1992 brood year) composed 80.9% of the total migration. Age-2. smolt (1991 brood year) were most numerous prior to June 5 (9.8% to 52.8%) and less thereafter (4.0% to 7.5%) as the outmigration progressed. The estimated number of smolt per sonar count ranged from 4.4 to 6.7 (Table 36).

This project was not operated in 1992, therefore we were unable to measure the total smolt production from the 1989 spawning escapement of 1,681,302 sockeye salmon or the 1990 spawning escapement of 730,038 sockeye salmon because outmigrating smolt from these brood years (e.g., 1989, age-2. smolt; 1990, age-1. smolt) were not enumerated (Table 37). The total smolt production of age-1. and -2. smolt from the record 1991 spawning escapement of 2,457,306 sockeye salmon was 64,057,099 smolt. Marine survival has averaged 8% for age-1. smolt for the 1981-88 brood years and 12% for age-2. smolt for the 1980-87 brood years (Table 38).

Age, weight, and length data were collected from 1,266 sockeye salmon smolt in 1994 (Table 39). Mean weight was 6.7 g for age-1. smolt and 11.2 g for age-2. smolt. Mean length was 89 mm for age-1. smolt and 109 mm for age-2. smolt. Age-1. smolt were 2% shorter than the 1958-1993 average length and 1% lighter; age-2. smolt were 3% shorter and 7% lighter than

average (Table 40). An additional 6,711 sockeye salmon smolt were sampled for length only (Table 41).

Fifty-five depth measurements were recorded for smolt schools passing over Ugashik River sonar arrays between May 22 and June 10 (Table 42). Schools passed at an average depth of 12 cm to 95 cm below the surface. Water depth over the sonar arrays at this site ranged from 294 cm to 318 cm during the peak smolt passage. Figure 25 shows the depth of smolt passage by hour for each array.

River and weather conditions were recorded at the counting site from May 20 to June 13 (Table 43). As mentioned previously, weather was not a major problem at Ugashik River smolt in 1994. Average water temperature was 6.5° C (range 4.5° C to 10.0° C), which was slightly warmer (NSC) than the 1983-93 average of 6.0° C (Table 44). The mean water temperature during the peak of the smolt outmigration -- June 4 -- was 7.0° C.

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Table 1. Sonar counts recorded from three arrays at the sockeye salmon smolt counting site on Kvichak River, 1994.

Smolt Day [a]	Sonar Count by Transducer Array			
	Inshore	Center	Offshore	Total
5/28 [b]	6,459	20,051	49,918	76,428
5/29 [c]	25,517	16,091	40,183	81,791
5/30	9,666	12,794	7,576	30,036
5/31	90,375	56,792	57,957	205,124
6/01	15,278	9,031	12,542	36,851
6/02	35,206	24,640	34,677	94,523
6/03 [d]	61,635	50,589	89,791	202,015
6/04	36,740	25,532	57,389	119,661
6/05	108,022	75,107	162,202	345,331
6/06	65,272	48,179	61,417	174,868
6/07	63,745	32,300	41,869	137,914
6/08 [d]	25,114	23,799	33,525	82,438
6/09 [d]	106,335	61,733	92,314	260,382
6/10	37,069	25,251	39,480	101,800
6/11	45,373	34,052	47,374	126,799
6/12 [e]	16,524	16,649	27,939	61,112
6/13	4,319	5,218	10,454	19,991
6/14	362	1,203	917	2,482
6/15	1,051	781	816	2,648
Total	754,062	539,792	868,340	2,162,194
Percent	34.8	25.0	40.2	

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

[b] Continuous flows of ice from Lake Iliamna's spring breakup made it impossible to count smolt with sonar in the Kvichak River prior to May 28. The first observations of birds capturing smolt from the river occurred on May 20 at Igiugig. From then on, terns, gulls, and mergansers were seen in the morning and evening feeding on smolt along gravel bars and islands of the river. Therefore an undetermined number of smolt passed the Kvichak smolt counting site for 7-to-8 days before the smolt counter began counting smolt at 1800 hours on May 28, 1994.

[c] A fyke net set from 1700-1730 hours on May 29 captured 200 sockeye salmon smolt and indicated the presence of relatively low numbers of smolt (CPUE=7) in the river.

[d] Fyke net catches indicate the presence of larger numbers of smolt in the river on the following dates and times:

1505-1526 hours on June 3, fyke net CPUE = 48
1640-1645 hours on June 8, fyke net CPUE = 100
2150-2205 hours on June 9, fyke net CPUE = 67

[e] Center array transducer #8 was found to be weak at 2300 hours on June 12. Although it continued to count smolt until the end of the project, the crew estimated that it was operating at about 50% efficiency. Since the efficiency of this transducer can not be quantified accurately, no correction factor was applied to the remaining center array counts.

Table 2. Daily number of sockeye salmon smolt emigrating seaward estimated with hydroacoustic equipment, Kvichak River, 1994.

	Age 1.			Age 2.			All Ages	
Smolt Day [a]	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5/28	787,938	33.2	787,938	1,584,656	66.8	1,584,656	2,372,594	2,372,594
5/29	899,701	33.2	1,687,639	1,809,425	66.8	3,394,081	2,709,126	5,081,720
5/30	511,794	51.7	2,199,433	477,562	48.3	3,871,643	989,356	6,071,076
5/31	4,503,438	58.4	6,702,871	3,209,249	41.6	7,080,892	7,712,687	13,783,763
6/01	828,639	60.3	7,531,510	544,872	39.7	7,625,764	1,373,511	15,157,274
6/02	1,552,634	47.9	9,084,144	1,690,127	52.1	9,315,891	3,242,761	18,400,035
6/03	5,028,952	65.4	14,113,096	2,664,106	34.6	11,979,997	7,693,058	26,093,093
6/04	3,182,839	68.3	17,295,935	1,478,612	31.7	13,458,609	4,661,451	30,754,544
6/05	4,460,936	38.1	21,756,871	7,244,485	61.9	20,703,094	11,705,421	42,459,965
6/06	6,780,158	85.3	28,537,029	1,170,308	14.7	21,873,402	7,950,466	50,410,431
6/07	4,312,009	73.6	32,849,038	1,545,107	26.4	23,418,509	5,857,116	56,267,547
6/08	1,745,742	58.1	34,594,780	1,257,944	41.9	24,676,453	3,003,686	59,271,233
6/09	7,413,325	70.4	42,008,105	3,121,455	29.6	27,797,908	10,534,780	69,806,013
6/10	3,413,994	77.6	45,422,099	984,916	22.4	28,782,824	4,398,910	74,204,923
6/11	4,995,129	85.1	50,417,228	878,038	14.9	29,660,862	5,873,167	80,078,090
6/12	2,272,984	85.4	52,690,212	387,966	14.6	30,048,828	2,660,950	82,739,040
6/13	761,208	85.7	53,451,420	127,223	14.3	30,176,051	888,431	83,627,471
6/14	85,594	85.7	53,537,014	14,305	14.3	30,190,356	99,899	83,727,370
6/15	101,190	85.7	53,638,204	16,912	14.3	30,207,268	118,102	83,845,472
	53,638,204	64.0		30,207,268	36.0		83,845,472	

[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 smolts, Kvichak River, 1994.

Smolt Day [a]	Mean Weight of Smolt (g)	Smolt per Count [b]
5/28	8.3	5.0
5/29	8.3	5.0
5/30	7.7	5.4
5/31	7.3	5.7
6/01	7.4	5.6
6/02	8.0	5.2
6/03	7.1	5.8
6/04	7.1	5.9
6/05	8.1	5.1
6/06	6.0	7.0
6/07	6.6	6.3
6/08	7.3	5.7
6/09	6.8	6.1
6/10	6.3	6.6
6/11	5.9	7.1
6/12	6.2	6.7
6/13	6.0	6.9
6/14	6.0	6.9
6/15	6.0	6.9

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

[b] Since 1993 a modified Bendix, Model 1982 hydroacoustic system has been used at Kvichak River smolt which requires a sonar expansion factor of five fish per count. This differs from the ten fish per count expansion factor that was used for the Bendix Model 1976 system at Kvichak from 1974 to 1992.

Table 4. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production composed by each age class, and number of smolt produced per spawner for 1956-1992 brood years, Kvichak River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age 1. (%[a])	Age 2. (%[a])	Age 3. (%[a])	Total	Per Spawner
		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 hydroacoustic 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	226,665,799	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)	0	19,957,080	16.92
1987	6,065,880	146,603,154 (78)	41,434,534 (22)	0	188,037,688	31.00
1988	4,065,216	46,569,569 (58)	34,266,421 (42)	0	80,835,990	19.88
1989	8,317,500	87,187,761 (59)	61,317,308 (41)	0	148,505,069	17.85
1990	6,970,020	18,172,700 (08)	204,626,879 (92)	0	222,799,579	31.97 [b]
1991	4,222,788	21,781,009 (42)	30,207,268 (58)		51,988,277	12.31 [b]
1992	4,725,864	53,638,204				
Max 80-89	17,505,268	150,421,026	331,384,545	123,975	414,898,140	47.44
Avg 80-89	6,129,408	62,059,029	73,127,658	19,952	135,206,639	24.59
Min 80-89	1,134,840	6,549,125	1,937,408	0	19,957,080	12.95

[a] Percent of total smolt production

[b] Preliminary total. Incomplete returns from brood year escapements.

Table 5. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1952-1992 brood years, Kvichak River.

Brood Year	Total Spawning Escapement	Age 1. Number of Smolt	Age 1. Adult[a] Returns	Age 1. Adult Returns per Smolt	Age 2. Number of Smolt	Age 2. Adult[a] Returns	Age 2. Adult Returns per Smolt
		Estimates of smolt numbers based upon fyke net catches					
1952	-	-			241,870	3,610,258	[b]
1953	-	18,198	152,165	[b]	47,373	424,627	[b]
1954	-	30,287	109,965	[b]	8,654	659,246	[b]
1955	-	22,253	351,240	[b]	66,679	1,132,813	[b]
1956	9,443,318	3,267,274	31,253,977	[b]	2,777,960	7,773,131	[b]
1957	2,842,810	85,916	488,844	[b]	552,603	3,591,552	[b]
1958	534,785	61,400	124,250	[b]	10,126	161,253	[b]
1959	680,000	26,038	328,287	[b]	72,180	217,593	[b]
1960	14,630,000	1,130,820	1,877,221	[b]	4,116,093	53,360,190	[b]
1961	3,705,849	113,338	524,416	[b]	1,603,464	2,971,816	[b]
1962	2,580,884	458,122	256,253	0.56	1,748,178	5,083,162	[b]
1963	338,760	64,377	98,571	[b]	23,377	1,008,242	[b]
1964	957,120	252,384	2,647,042	[b]	222,528	3,093,042	[b]
1965	24,325,926	2,866,214	10,349,415	[b]	5,475,362	34,671,692	[b]
1966	3,775,184	648,321	1,594,186	[b]	541,017	4,657,432	[b]
1967	3,216,208	594,327	621,690	[b]	298,282	900,307	[b]
1968	2,557,440	185,356	332,177	[b]	-		
		Estimates of smolt numbers based upon hydroacoustic techniques					
1968	2,557,440	-			5,959,383	209,138	0.04
1969	8,394,204	85,723,430	449,791	0.01	54,159,340	4,824,026	0.09
1970	13,935,306	464,219	56,778	0.12	191,842,930	15,351,498	0.08
1971	2,387,392	5,123,400	337,314	0.07	21,423,246	2,489,981	0.12
1972	1,009,962	2,740,610	436,837	0.16	-	1,504,435	[b]
1973	226,554	-	1,606,766	[b]	3,031,287	818,529	0.27
1974	4,433,844	108,356,892	8,353,542	0.08	114,269,848	17,796,617	0.16
1975	13,140,450	78,308,251	6,920,452	0.09	213,364,470	31,164,576	0.15
1976	1,965,282	32,226,544	6,132,390	0.19	26,423,348	4,431,284	0.17
1977	1,341,144	28,758,191	2,912,441	0.10	10,410,467	309,369	0.03
1978	4,149,288	182,442,540	2,991,655	0.02	32,294,536	2,151,024	0.07
1979	11,218,434	219,928,232	20,621,724	0.09	89,300,703	21,516,038	0.24
1980	22,505,268	150,421,026	4,534,253	0.03	76,244,773	8,508,770	0.11
1981	1,754,358	6,549,125	1,019,361	0.16	37,595,987	1,098,376	0.03
1982	1,134,840	51,893,988	995,144	0.02	1,937,408	663,241	0.34
1983	3,569,982	23,590,443	11,612,066	0.49	53,260,693	1,773,436	0.03
1984	10,490,670	83,470,460	4,455,429	0.05	331,384,545	19,441,947	0.06
1985	7,211,046	11,178,398	2,311,147	0.21	87,004,194	14,991,491	0.17
1986	1,179,322	13,126,363	1,804,257	0.14	6,830,717	2,721,114	0.40
1987	6,065,880	146,603,154	6,710,655	0.05	41,434,534	5,217,874	0.13
1988	4,065,216	46,569,569	4,979,438	0.11	34,266,421	4,901,646	0.14[c]
1989	8,317,500	87,187,761	3,799,794	0.04[c]	61,317,308	18,912,737	0.31[c]
1990	6,970,020	18,172,700	1,548,632	0.09[c]	204,626,879	83,069	0.00[c]
1991	4,222,788	21,781,009	874	0.00[c]	30,207,268		
1992	4,725,864	53,638,204					
Max 78-87	22,505,268	219,928,232	20,621,724	0.49	331,384,545	21,516,038	0.40
Avg 78-87	6,927,909	88,920,373	5,705,569	0.13	75,728,809	7,808,331	0.16
Min 78-87	1,134,840	6,549,125	995,144	0.02	1,937,408	663,241	0.03

[a] Includes estimates of returns through 1994.
[b] Insufficient smolt samples collected to perform this calculation.
[c] Future adult returns will increase these values.

Table 6. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Kvichak River, 1994.

	Age 1.					Age 2.				
Smolt Day [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
5/29	86	11.3	6.4	2.24	25	101	16.3	9.7	4.16	76
5/30	84	11.1	5.8	1.71	41	104	13.5	9.7	3.50	60
5/31	85	9.4	6.0	2.11	60	100	13.2	9.4	3.52	40
6/01	86	11.1	6.0	2.03	60	103	11.4	9.7	3.03	40
6/02	84	7.0	5.7	1.68	48	105	16.8	10.2	3.91	54
6/03	84	13.5	5.7	2.69	73	104	12.4	10.5	3.94	29
6/04	86	13.6	5.8	2.22	73	104	11.2	9.9	5.24	28
6/05	86	12.3	6.2	2.28	43	102	12.5	9.7	3.03	59
6/06	83	11.7	5.0	2.31	94	98	8.7	7.9	2.24	8
6/07	84	11.1	5.2	2.11	81	101	11.2	8.8	2.29	21
6/08	85	17.3	6.2	4.00	56	101	19.0	9.8	4.74	45
6/09	85	10.8	5.8	2.32	80	102	12.3	9.3	3.13	21
6/10	82	14.4	5.4	2.71	81	103	9.3	9.5	2.53	19
6/11	81	12.8	5.1	2.71	90	104	11.7	9.7	2.20	12
6/12	84	12.7	5.8	2.96	94	99	7.6	9.1	1.80	7
6/13	81	11.1	5.3	2.64	97	96	9.2	8.5	2.16	3
Total					1,096					522
Mean	84		5.7			102		9.5		

[a] Sample day began at 1200 hours and ended at 1159 hours 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, 1955-1994.

	Age 1.				Age 2.				Age 3.				
Year of Migration	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Total Estimate [a]
1955	1953	7	89	-	1952	93	-	-	1951	0	-	-	260,068
1956	1954	39	92	-	1953	61	116	-	1952	0	-	-	77,660
1957	1955	72	96	7.3	1954	28	120	14.4	1953	0	-	-	30,907
1958	1956	98	84	4.6	1955	2	114	-	1954	0	-	-	3,333,953
1959	1957	3	80	-	1956	97	99	7.6	1955	0	-	-	2,863,876
1960	1958	10	91	6.3	1957	90	108	10.3	1956	0	-	-	614,003
1961	1959	72	92	6.8	1958	28	117	13.1	1957	0	-	-	36,164
1962	1960	94	82	4.3	1959	6	110	9.9	1958	0	-	-	1,203,000
1963	1961	3	83	4.8	1960	97	98	7.5	1959	0	-	-	4,229,431
1964	1962	22	87	5.2	1961	78	108	9.8	1960	0	-	-	2,061,586
1965	1963	4	90	6.8	1962	96	109	11.3	1961	0	-	-	1,812,555
1966	1964	92	94	7.4	1963	8	114	12.6	1962	0	-	-	275,761
1967	1965	93	86	5.9	1964	7	118	14.2	1963	0	-	-	3,088,742
1968	1966	11	88	5.5	1965	89	104	9.2	1964	0	-	-	6,123,683
1969	1967	52	92	5.7	1966	48	109	10.6	1965	0	-	-	1,135,344
1970	1968	38	91	6.0	1967	62	110	11.0	1966	0	-	-	483,638
1971	1969	93	90	5.8	1968	7	111	11.1	1967	0	-	-	91,682,813
1972	1970	1	80	4.2	1969	99	106	10.0	1968	0	-	-	54,623,559
1973	1971	3	86	5.1	1970	97	97	8.3	1969	0	-	-	196,966,331
1974	1972	9	96	8.3	1971	79	111	13.1	1970	12	124	17.5	27,082,626
1975	1973	63	98	8.4	1972	37	122	16.4	1971	0	-	-	15,632,531
1976	1974	97	88	5.8	1973	3	121	14.2	1972	0	-	-	111,388,180
1977	1975	38	86	5.5	1974	62	106	10.1	1973	0	-	-	192,578,099
1978	1976	12	88	6.0	1975	88	97	7.8	1974	0	-	-	245,591,014
1979	1977	51	90	6.0	1976	49	109	10.3	1975	0	-	-	55,181,540
1980	1978	94	88	5.9	1977	6	110	10.7	1976	0	-	-	192,853,007
1981	1979	89	85	5.4	1978	11	108	10.2	1977	0	-	-	252,222,769
1982	1980	58	84	5.1	1979	39	103	9.1	1978	0	-	-	239,721,729
1983	1981	8	80	4.9	1980	92	98	8.5	1979	0	-	-	82,793,899
1984	1982	58	90	6.8	1981	42	104	10.0	1980	0	-	-	89,489,975

-Continued-

Table 7. (p 2 of 2)

Year of Migration	Age 1. Brood Year	Age 1. Percent of Total Estimate	Age 1. Mean Length (mm)	Age 1. Mean Weight (g)	Age 2. Brood Year	Age 2. Percent of Total Estimate	Age 2. Mean Length (mm)	Age 2. Mean Weight (g)	Age 3. Brood Year	Age 3. Percent of Total Estimate	Age 3. Mean Length (mm)	Age 3. Mean Weight (g)	Total Estimate [a]
1985	1983	92	85	5.3	1982	8	102	9.2	1981	0	-	-	25,527,851
1986	1984	61	84	5.5	1983	39	107	10.4	1982	0	102	9.1	136,733,218
1987	1985	3	82	4.5	1984	97	96	7.0	1983	0	97	8.5	342,686,918
1988	1986	13	86	5.6	1985	87	99	8.3	1984	0	107	9.8	100,173,692
1989	1987	95	85	5.5	1986	5	108	10.8	1985	0	105	9.5	153,464,216
1990	1988	53	87	6.1	1987	47	105	10.5	1986	0	-	-	88,004,103
1991	1989	72	85	5.5	1988	28	105	9.9	1987	0	-	-	121,454,182
1992	1990	23	84	5.6	1989	77	100	9.3	1988	0	_	_	79,490,008
1993	1991	10	86	6.0	1990	90	97	8.2	1989	0	_	_	226,407,888
Mean			87	5.8			107	10.4			107	10.9	
1994	1992	64	84	5.7	1991	36	102	9.5	1990	0	_	_	83,845,472

[a] Estimates of smolt numbers for 1955 to 1970 based on fyke net catches; estimates of smolt numbers for 1971 to 1994 based on hydroacoustic techniques.

Table 8. Mean fork length and estimated weight for age-1. and -2. sockeye salmon smolt, Kvichak River, 1994.

Smolt Day [b]	Estimated Age 1. [a] Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size	Estimated Age 2. [a] Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size
5/29	87	16.0	6.0	198	101	23.9	9.4	402
5/30	83	17.7	5.5	195	104	22.8	10.1	304
5/31	86	17.1	5.9	319	100	15.9	9.1	181
6/01	86	16.6	5.9	338	103	18.0	9.8	209
6/02	84	16.2	5.7	258	104	22.0	10.1	271
6/03	84	17.2	5.7	374	103	19.5	9.8	181
6/04	85	17.1	5.7	408	104	20.1	10.0	148
6/05	85	14.0	5.9	168	101	19.3	9.4	353
6/06	83	19.0	5.5	505	97	9.9	8.6	43
6/07	84	18.5	5.7	415	101	18.5	9.5	113
6/08	84	17.7	5.6	327	102	19.4	9.5	225
6/09	84	18.2	5.7	357	101	17.7	9.5	126
6/10	82	18.6	5.4	433	101	13.1	9.4	82
6/11	81	21.2	5.2	476	100	12.0	9.1	36
6/12	84	20.7	5.6	464	97	10.0	8.5	38
6/13	82	17.2	5.3	389	110	40.4	12.3	13
Total				5,624				2,725
Mean	84		5.6		102		9.6	

[a] Length-weight parameters by age group and discriminating length used to seperate ages from May 29 to June 13 were:

Age 1. a = -8.8355 b = 2.3796 r^2 = 0.5913 n = 1,096
Age 2. a = -8.8943 b = 2.4087 r^2 = 0.7340 n = 519

Discriminating Length = 93.38 mm

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

Table 9. Depth of sockeye salmon smolt passage at Kvichak River sonar site, May 28 to June 10, 1994.

	Depth of Passage (cm)							
	Inshore Array[a] Smolt Schools		Center Array[b] Smolt Schools		Offshore Array[c] Smolt Schools		All Combined Smolt Schools	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Mean	32	195	33	171	26	175	30	180
Minimum	0	130	0	30	0	110	0	30
Maximum	95	240	139	232	129	280	139	280
n	24	24	9	9	21	21	54	54

[a] Average depth of inshore array at 0100 hours on smolt day 5/21 was 337 cm.

[b] Average depth of center array at 0100 hours on smolt day 5/21 was 328 cm.

[c] Average depth of offshore array at 0100 hours on smolt day 5/21 was 307 cm.

Table 10. Climatological and hydrological observations made at sockeye salmon smolt counting site at 0800 and 2000 hours, Kvichak River, 1994.

Date	Cloud Cover [a]		Wind Velocity (km/h)		Air Temp (°C)		Water Temp (°C)		Percipitation (mm)	Water Clarity [b]
	0800	2000	0800	2000	0800	2000	0800	2000		
5/22	0	0	-	-	-	-	1.5	-	0.0	murky
5/23	0	0	-	-	-	-	1.5	-	0.0	murky
5/24	4	0	32 E	-	-	-	1.5	-	3.3	murky
5/25	4	0	0-08 SW	-	6.0	-	3.0	-	0.0	murky
5/26	1	0	0-08 SW	-	6.0	-	2.5	-	0.0	murky
5/27	1	0	16 E	-	7.0	-	1.5	-	0.0	murky
5/28	1	4	16-24 S	0-08 E	8.0	14.0	4.0	4.0	1.0	murky
5/29	2	3	8-16 SW	8-16 SW	7.0	10.5	3.5	4.0	2.5	clear
5/30	3	3	16-24 SW	16-24 E	4.0	10.0	4.0	4.5	0.0	clear
5/31	2	1	0-08 E	0-05 var	5.0	10.5	5.0	5.0	0.0	clear
6/01	3	2	8-16 W	8-16 SW	4.0	12.5	5.0	5.0	0.0	clear
6/02	5	3	08 SW	08 E	3.0	11.0	4.0	5.0	0.0	clear
6/03	2	3	0	8-16 S	7.0	10.5	5.5	6.0	0.0	clear
6/04	4	3	0-08 SW	0-08 E	4.0	14.0	5.0	7.0	1.0	clear
6/05	3	3	0-08 E	24-40 E	8.0	12.5	6.0	6.0	0.0	brown
6/06	1	2	0-08 E	24-32 E	7.0	13.0	7.0	8.0	0.0	murky
6/07	3	4	16-24 E	24-32 E	7.0	10.0	7.0	8.0	0.0	clear
6/08	4	3	8-16 E	24-32 E	8.0	9.5	6.0	7.0	0.0	clear
6/09	3	4	8-16 E	8-16 E	8.0	12.0	6.5	8.0	0.0	clear
6/10	3	3	0-08 E	16-24 E	7.0	11.0	8.0	8.0	1.3	clear
6/11	2	3	0-08 E	0	8.0	14.0	9.0	11.0	0.0	clear
6/12	2	4	0	16-32 SW	10.0	14.0	10.5	10.5	0.0	clear
6/13	4	1	8-16 SE	8-16 SW	6.0	16.0	9.0	10.0	trace	clear
6/14	5	2	8-16 SW	16-40 S	6.0	14.0	8.0	10.0	0.0	clear
6/15	3	4	24 S	16-32 SW	4.0	8.0	7.0	8.0	0.0	clear
6/16	5	0	8-16 S	-	5.0	-	7.0	-	0.0	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

[b] Water clarity at 0800 hours

Table 11. Water temperatures at sockeye salmon smolt counting site, Kvichak River, 1963-1994.

Year	Sample Period	Water Temperature (°C) Minimum	Maximum	Mean
1963	May 16 - Jun 14	2.2	8.9	5.5
1964	May 18 - Jun 14	0.0	5.6	2.6
1965	May 17 - Jun 11	0.0	8.9	4.4
1966	May 16 - Jun 26	0.0	11.1	4.7
1967	May 17 - Jun 20	1.1	9.4	6.9
1968	May 12 - Jun 12	3.3	8.3	5.4
1969	May 16 - Jun 18	0.3	7.8	3.9
1970	May 13 - Jun 07	2.8	11.1	6.8
1971	May 17 - Jun 20	1.1	3.3	2.4
1972	May 18 - Jun 18	0.6	5.0	2.9
1973	May 15 - Jun 14	2.9	8.9	4.9
1974	May 13 - Jun 09	3.0	8.0	6.2
1975	May 17 - Jun 15	2.0	8.0	3.8
1976	May 18 - Jun 19	2.0	9.5	3.9
1977	May 17 - Jun 14	3.0	9.5	6.4
1978	May 19 - Jun 09	5.0	11.0	7.6
1979	Jun 01 - Jun 10	8.0	10.0	8.6
1980	May 16 - Jun 18	1.5	9.0	5.5
1981	May 15 - Jun 09	7.0	10.0	8.2
1982	May 14 - Jun 15	2.5	8.5	4.9
1983	May 19 - Jun 14	5.2	10.5	7.9
1984	May 19 - Jun 11	5.5	10.0	7.9
1985	May 23 - Jun 20	2.0	7.0	4.6
1986	May 18 - Jun 12	1.0	7.0	4.6
1987	May 21 - Jun 13	4.5	9.0	6.7
1988	May 17 - Jun 17	3.0	11.0	7.1
1989	May 19 - Jun 16	3.0	8.8	5.8
1990	May 22 - Jun 15	3.5	9.5	7.3
1991	May 23 - Jun 17	1.0	8.5	4.8
1992	May 22 - Jun 14	5.0	10.0	7.8
1993	May 19 - Jun 12	4.0	11.0	6.6
	Mean	2.8	8.8	5.7
1994	May 22 - Jun 16	1.5	11.0	6.1

Table 12. Sonar counts recorded from three arrays at the sockeye salmon smolt counting site on Naknek River, 1994.

Smolt Day [a]	Sonar Count by Transducer Array			
	Inshore	Center	Offshore	Total
5/19 [b]	572	1,714	1,256	3,542
5/20	3,865	21,070	3,352	28,287
5/21	3,289	13,804	6,693	23,786
5/22 [c]	11,463	21,385	32,414	65,262
5/23	5,904	23,269	6,945	36,118
5/24	7,738	12,880	3,216	23,834
5/25	1,299	1,937	3,872	7,108
5/26	3,262	4,690	5,904	13,856
5/27	4,001	3,648	6,422	14,071
5/28	53,998	42,701	34,927	131,626
5/29 [d]	19,025	5,893	16,227	41,145
5/30	8,562	14,868	24,975	48,405
5/31 [e,f]	12,161	25,583	15,936	53,680
6/01 [e]	23,266	23,491	33,372	80,129
6/02	5,827	16,203	23,020	45,050
6/03 [g]	13,459	31,642	47,224	92,325
6/04	6,300	3,878	3,409	13,587
6/05	15,233	30,850	40,456	86,539
6/06	17,582	95,192	113,540	226,314
6/07	61,117	171,220	150,906	383,243
6/08	49,186	161,589	168,898	379,673
6/09 [e]	52,663	184,407	115,898	352,968
6/10	46,188	92,234	91,726	230,148
6/11	29,051	35,701	14,833	79,585
6/12	49,451	67,148	53,377	169,976
6/13	24,174	16,406	8,484	49,064
6/14	29,261	61,179	23,538	113,978
6/15	18,594	21,423	9,983	50,000
6/16	5,301	9,930	7,256	22,487
6/17	8,361	18,515	7,478	34,354
6/18	4,365	3,271	5,208	12,844
6/19	10,940	12,718	19,007	42,665
Total	605,458	1,250,439	1,099,752	2,955,649
Percent	20.5	42.3	37.2	

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

[b] The first smolt counts on the smolt counter were reported at 1100 hours on smolt day May 19.

[c] All offshore array counts from 1700 hours May 22 till the end of the project were multiplied by 1.11 to account for a bad transducer # 6.

[d] Interpolated data for all array: 2100 hours on May 29 due to high wind

[e] Peak fyke net catch per unit effort (CPUE) dates and times:
0147-0149 hours on May 31, CPUE = 250
0149-0152 hours on June 1, CPUE = 233
0132-0135 hours on June 9, CPUE = 333 (1994 peak)

[f] All center array counts from 1200 hours May 31 till the end of the project were multiplied by 1.11 to account for a bad transducer #2.

[g] All inshore array counts from 1200 hours June 3 till the end of the project were multiplied by 1.11 to account for a bad transducer #7.

Table 13. Daily number of sockeye salmon smolt migrating seaward estimated with hydroacoustic equipment, Naknek River, 1994.

Smolt Day [a]	Age 1. Number	Age 1. Percent	Age 1. Cumulative Total	Age 2. Number	Age 2. Percent	Age 2. Cumulative Total	All Ages Daily Total	All Ages Cumulative Total
5/19	804	1.3	804	61,564	98.7	61,564	62,368	62,368
5/20	6,204	1.3	7,008	474,793	98.7	536,357	480,997	543,365
5/21	5,277	1.3	12,285	403,809	98.7	940,166	409,086	952,451
5/22	215,625	16.0	227,910	1,132,035	84.0	2,072,201	1,347,660	2,300,111
5/23	115,795	16.0	343,705	607,927	84.0	2,680,128	723,722	3,023,833
5/24	50,519	10.9	394,224	414,669	89.1	3,094,797	465,188	3,489,021
5/25	46,500	29.8	440,724	109,489	70.2	3,204,286	155,989	3,645,010
5/26	90,680	29.8	531,404	213,515	70.2	3,417,801	304,195	3,949,205
5/27	92,690	29.8	624,094	218,247	70.2	3,636,048	310,937	4,260,142
5/28	717,915	24.8	1,342,009	2,181,582	75.2	5,817,630	2,899,497	7,159,639
5/29	218,518	24.1	1,560,527	689,705	75.9	6,507,335	908,223	8,067,862
5/30	270,803	24.1	1,831,330	854,731	75.9	7,362,066	1,125,534	9,193,396
5/31	563,057	41.5	2,394,387	792,401	58.5	8,154,467	1,355,458	10,548,854
6/01	1,339,949	57.7	3,734,336	981,515	42.3	9,135,982	2,321,464	12,870,318
6/02	388,673	35.4	4,123,009	710,826	64.6	9,846,808	1,099,499	13,969,817
6/03	1,415,192	55.2	5,538,201	1,149,026	44.8	10,995,834	2,564,218	16,534,035
6/04	110,217	32.7	5,648,418	226,839	67.3	11,222,673	337,056	16,871,091
6/05	893,980	41.3	6,542,398	1,270,097	58.7	12,492,770	2,164,077	19,035,168
6/06	2,212,375	40.5	8,754,773	3,248,932	59.5	15,741,702	5,461,307	24,496,475
6/07	3,477,210	38.0	12,231,983	5,675,752	62.0	21,417,454	9,152,962	33,649,437
6/08	1,436,743	17.8	13,668,726	6,634,850	82.2	28,052,304	8,071,593	41,721,030
6/09	4,176,835	44.3	17,845,561	5,255,945	55.7	33,308,249	9,432,780	51,153,810
6/10	2,630,399	42.8	20,475,960	3,521,143	57.2	36,829,392	6,151,542	57,305,352
6/11	1,933,149	75.1	22,409,109	641,636	24.9	37,471,028	2,574,785	59,880,137
6/12	3,667,778	70.2	26,076,887	1,554,745	29.8	39,025,773	5,222,523	65,102,660
6/13	1,110,037	71.1	27,186,924	452,295	29.0	39,478,068	1,562,332	66,664,992
6/14	2,581,671	72.8	29,768,595	963,606	27.2	40,441,674	3,545,277	70,210,269
6/15	876,332	60.2	30,644,927	578,885	39.8	41,020,559	1,455,217	71,665,486
6/16	393,241	60.2	31,038,168	259,766	39.8	41,280,325	653,007	72,318,493
6/17	587,535	60.2	31,625,703	388,112	39.8	41,668,437	975,647	73,294,140
6/18	231,229	60.2	31,856,932	152,744	39.8	41,821,181	383,973	73,678,113
6/19	758,315	60.2	32,615,247	500,926	39.8	42,322,107	1,259,241	74,937,354
	32,615,247	43.5		42,322,107	56.5		74,937,354	

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

Table 14. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolts, Naknek River, 1994.

Smolt Day [a]	Mean Weight of Smolt (g)	Smolt per Count
5/19	12.6	3.3
5/20	12.6	3.3
5/21	12.6	3.3
5/22	10.7	3.9
5/23	10.7	3.9
5/24	11.3	3.7
5/25	10.1	4.1
5/26	10.1	4.1
5/27	10.1	4.1
5/28	10.3	4.0
5/29	10.5	4.0
5/30	10.5	4.0
5/31	9.6	4.3
6/01	8.6	4.8
6/02	9.9	4.2
6/03	8.8	4.7
6/04	10.3	4.0
6/05	9.8	4.2
6/06	9.9	4.2
6/07	10.1	4.1
6/08	11.3	3.7
6/09	9.4	4.4
6/10	9.7	4.3
6/11	7.8	5.3
6/12	8.4	5.0
6/13	8.1	5.1
6/14	8.0	5.2
6/15	8.7	4.8
6/16	8.7	4.8
6/17	8.7	4.8
6/18	8.7	4.8
6/19	8.7	4.8

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

Table 15. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production composed by each age class, and number of smolt produced per spawner for 1978-1992 brood years, Naknek River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced							
		Age 1.	(%)[a]	Age 2.	(%)[a]	Age 3.	Total	Per Spawner	
1978	813,378	-		-		-	-	-	
1979	925,362	-		12,898,936		23,256	-	-	
1980	2,644,698	115,624,396	(88)	16,497,326	(12)	594,898	132,716,620	50.18	
1981	1,796,220	36,798,239	(43)	48,825,473	(57)	20,579	85,644,291	47.68	
1982	1,155,552	32,139,569	(71)	13,370,305	(29)	37,647	45,547,521	39.42	
1983	888,294	6,306,803	(25)	19,147,877	(75)	-	25,454,680[b]	28.66[b]	
1984	1,242,474	22,143,831		-		-	[b]	-	
1985	1,849,938	-		-		-	[b]	-	
1986	1,977,645	-		-		-	[b]	-	
1987	1,061,806	-		-		-	[b]	-	
1988	1,037,862	-		-		-	[b]	-	
1989	1,161,984	-		-		0	[b]	-	
1990	2,092,578	-		28,838,668		0	[b]	-	
1991	3,578,508	24,183,838		42,322,107			66,505,945[c]	18.58[c]	
1992	1,606,650	32,615,247							
Max	3,578,508	115,624,396		48,825,473		594,898	132,716,620	50.18	
Avg	1,644,255	38,544,560		25,985,813		112,730	87,969,477	45.76	
Min	888,294	6,306,803		12,898,936		0	45,547,521	39.42	

[a] Percent of total smolt production

[b] No Naknek River smolt enumeration project conducted from 1987 to 1992. Therefore smolt production data for brood years 1983, 1984, 1989, and 1990 are incomplete, and no smolt data exists for brood years 1985 to 1988.

[c] Outmigrations of Age 3. smolt in 1995 could increase these values.

Table 16. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1978-1992 brood years, Naknek River.

Brood Year	Total Spawning Escapement	Age 1. Number of Smolt	Age 1. Adult[a] Returns	Age 1. Adult Returns per Smolt	Age 2. Number of Smolt	Age 2. Adult[a] Returns	Age 2. Adult Returns per Smolt	Age 3. Number of Smolt	Age 3. Adult[a] Returns	Age 3. Adult Returns per Smolt
1978	813,378	-	2,037,650	[b]	-	1,654,963	[b]	-	1,514	[b]
1979	925,362	-	3,424,915	[b]	12,898,936	1,204,976	0.09	23,256	6,523	0.27
1980	2,644,698	115,624,396	2,238,099	0.02	16,497,326	2,034,978	0.12	594,898	0	0.00
1981	1,796,220	36,798,239	3,366,909	0.09	48,825,473	1,421,583	0.03	20,579	0	0.00
1982	1,155,552	32,139,569	1,383,640	0.04	13,370,305	656,761	0.05	37,647	0	0.00
1983	888,294	6,306,803	651,964	0.10	19,147,877	822,912	0.04	-	739	[b]
1984	1,242,474	22,143,831	1,402,754	0.06	-	3,036,120	[b]	-	8,721	[b]
1985	1,849,938	-	4,226,241	[b]	-	2,783,537	[b]	-	10,187	[b]
1986	1,977,645	-	9,579,674	[b]	-	4,129,493	[b]	-	4,531	[b]
1987	1,061,806	-	1,676,821	[b]	-	3,815,958	[b]	-	2,639 [c]	[b]
1988	1,037,862	-	1,105,675	[b]	-	1,063,398 [c]	[b]	-	1,634 [c]	[b]
1989	1,161,984	-	1,149,582 [c]	[b]	-	1,157,699 [c]	[b]	0	0 [c]	[b]
1990	2,092,578	-	405,012 [c]	[b]	28,838,668	46,327 [c]	[b]	0		
1991	3,578,508	24,183,838	12,538 [c]	[b]	42,322,107					
1992	1,606,650	32,615,247								
Max	3,578,508	115,624,396	9,579,674	0.10	48,825,473	4,129,493	0.12	594,898	10,187	0.28
Avg	1,644,255	38,544,560	2,905,669	0.06	25,985,813	2,211,813	0.07	112,730	3,838	0.07
Min	888,294	6,306,803	651,964	0.02	12,898,936	656,761	0.03	0	0	0.00

[a] Includes estimates of returns through 1994.

[b] Insufficient smolt data to perform this calculation.

[c] Future adult returns will increase these values.

Table 17. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Naknek River, 1994.

	Age 1.					Age 2.				
Smolt Day [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
5/20	90		5.4		1	115	15.4	12.5	4.83	49
5/21	92	13.5	6.9	2.71	3	114	20.9	12.3	6.38	97
5/22	100	23.8	8.3	5.05	21	108	21.3	10.4	5.87	79
5/23	99	28.2	8.8	6.00	36	109	19.7	10.9	5.69	63
5/24	95	19.0	8.1	3.68	20	108	18.8	11.4	4.78	80
5/25					0					0
5/26	97	18.0	8.4	3.98	23	108	12.3	10.4	3.29	19
5/27	98	15.1	9.5	4.35	62	103	15.9	10.8	3.80	37
5/28	96	20.9	8.2	6.17	46	104	12.7	10.0	5.15	51
5/29	94	20.5	7.5	4.65	31	106	11.4	10.0	3.20	19
5/30	97	17.1	8.8	4.04	27	108	20.4	11.1	5.83	72
5/31	96	15.4	8.0	3.64	41	107	22.2	10.2	5.52	59
6/01	90	14.1	6.3	3.97	54	103	15.9	8.8	4.15	44
6/02	95	21.6	7.4	4.99	43	113	17.7	11.8	5.14	56
6/03	92	19.0	6.8	4.78	43	108	19.1	10.9	5.93	57
6/04	94	18.8	7.8	4.70	25	110	25.7	11.7	7.45	73
6/05	89	19.3	6.7	4.18	60	102	18.3	9.7	5.04	36
6/06	91	17.3	7.4	4.62	34	111	22.4	12.7	7.64	65
6/07	88	21.3	6.3	4.93	57	111	19.0	12.2	5.80	42
6/08	97	16.6	8.1	4.27	29	112	18.9	12.4	6.46	71
6/09	93	23.5	6.9	6.05	42	111	22.7	11.6	7.42	58
6/10	91	17.4	7.2	4.17	29	108	17.0	11.2	5.37	21
6/11	86	18.4	6.1	3.91	95	101	9.7	9.3	2.96	5
6/12	90	20.3	7.1	4.76	74	107	11.2	10.9	2.76	6
6/13	91	22.8	7.1	5.38	78	101	18.7	9.2	4.51	22
6/14	90	10.6	7.0	2.52	41	97	9.8	8.7	2.34	9
6/15 [b]										
6/16	90	16.9	6.9	3.90	41	110	17.5	12.3	4.93	9
6/17 [b]										
6/18	87	13.6	6.4	2.78	46	108	4.4	10.9	1.33	4
Total					1,102					1,203
Mean	93		7.4			107		10.9		

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

[b] Fyke net not fished.

Table 18. Age composition of total migration, and mean fork length and weight by age class for sockeye salmon smolt, Naknek River, 1957-1994.

	Age 1.				Age 2.				Age 3.				
Year of Migration	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Total Estimate [a]
1957	1955	58	111	13.1	1954	42	112	13.1	1953	-	-	-	3,040,416
1958	1956	96	91	6.9	1955	4	114	11.3	1954	-	-	-	10,060,200
1959	1957	81	97	8.2	1956	19	106	10.1	1955	0	-	-	12,465,487
1960	1958	53	99	8.8	1957	47	109	11.9	1956	0	-	-	6,691,377
1961	1959	78	103	10.8	1958	22	113	13.8	1957	0	-	-	5,612,647
1962	1960	49	105	10.4	1959	51	112	12.5	1958	-	-	-	16,462,216
1963	1961	41	98	8.1	1960	59	114	12.8	1959	0	-	-	14,900,855
1964	1962	31	97	7.7	1961	69	110	11.0	1960	0	-	-	7,228,339
1965	1963	60	99	8.4	1962	40	114	13.0	1961	0	-	-	24,708,672
1966	1964	34	106	10.6	1963	66	118	14.2	1962	-	-	-	9,212,910
1967	1965	44	113	13.1	1964	56	119	14.7	1963	0	-	-	9,407,200
1968	1966	41	99	8.4	1965	57	108	11.1	1964	0	-	-	18,596,039
1969	1967	60	100	7.5	1966	40	112	12.1	1965	-	-	-	11,546,017
1970	1968	55	100	9.0	1967	45	114	12.1	1966	-	-	-	3,652,864
1971	1969	74	102	8.8	1968	26	120	13.5	1967	-	-	-	10,864,064
1972	1970	7	98	9.1	1969	93	110	11.9	1968	-	-	-	10,990,739
1973	1971	27	106	10.7	1970	72	114	12.9	1969	1	122	15.2	2,712,150
1974	1972	19	104	10.3	1971	81	118	14.5	1970	0	109	11.3	819,369
1975	1973	48	98	8.3	1972	52	111	12.1	1971	0	109	11.5	9,188,154
1976	1974	39	91	7.2	1973	60	107	13.4	1972	1	131	22.2	2,139,980
1977	1975	11	92	7.2	1974	89	113	11.9	1973	-	-	-	3,223,885
1978	1976	-	96	8.3	1975	-	105	11.0	1974	-	-	-	-
1982	1980	96	94	8.0	1979	4	100	14.7	1978	-	-	-	128,523,332
1983	1981	69	94	8.0	1980	31	110	12.2	1979	0	133	19.1	53,318,822
1984	1982	39	97	8.8	1981	60	108	11.4	1980	1	124	16.7	81,559,941
1985	1983	32	96	8.7	1982	68	109	11.7	1981	0	119	15.6	19,697,687
1986	1984	54	99	9.9	1983	46	116	14.9	1982	0	134	21.8	41,329,355
1993	1991	46	95	8.8	1990	54	109	12.4	1989	0			53,021,762
Mean			99	8.7			112	12.9			123	16.7	
1994	1992	43	93	7.4	1991	57	107	10.9	1990	0			74,937,354

[a] Estimates of smolt numbers from 1957-1977 based on fyke net catches; no estimate of smolt numbers for 1978 or 1987-1992; estimates of smolt numbers for 1982-1986 and 1993-1994 based on hydroacoustic techniques.

Table 19. Mean fork length and estimated weight for age-1. and -2. sockeye salmon smolt, Naknek River, 1994.

	Estimated Age 1.[a]				Estimated Age 2.[a]			
Smolt Day [b]	Mean Length (mm)	Estimated Std. Error	Weight (g)	Sample Size	Mean Length (mm)	Estimated Std. Error	Weight (g)	Sample Size
5/20				0	118	7.0	13.5	17
5/21	99	1.1	8.6	3	115	23.1	12.7	244
5/22	95	15.3	7.9	40	111	19.7	11.5	209
5/23	94	17.2	7.5	81	109	21.4	11.0	470
5/24	94	15.7	7.7	59	111	26.3	11.6	477
5/25				0				0
5/26	95	11.3	7.8	36	106	15.2	10.3	132
5/27	95	17.0	7.7	189	107	24.5	10.7	437
5/28	94	19.0	7.5	158	108	23.2	10.8	455
5/29	92	16.6	7.1	78	109	24.4	11.1	156
5/30	95	14.4	7.8	110	109	24.8	11.3	460
5/31	93	18.7	7.4	287	107	23.1	10.5	299
6/01	90	24.2	6.7	427	108	23.2	10.8	186
6/02	90	22.5	6.8	241	109	27.2	11.2	353
6/03	89	27.1	6.6	402	108	22.9	10.9	186
6/04	90	21.1	6.8	235	111	28.5	11.6	350
6/05	90	23.0	6.7	259	112	31.8	12.0	316
6/06	90	24.4	6.7	293	111	25.6	11.6	288
6/07	90	24.1	6.7	269	112	30.0	12.1	379
6/08	93	17.9	7.5	116	112	28.7	11.9	489
6/09	88	23.7	6.4	301	110	23.6	11.4	262
6/10	91	21.9	6.9	211	109	21.0	11.0	191
6/11	89	22.8	6.6	515	107	17.6	10.7	84
6/12	91	24.2	7.0	487	106	17.2	10.5	118
6/13	89	24.5	6.5	509	109	18.4	11.1	103
6/14	88	20.3	6.4	348	107	11.1	10.7	31
6/15 [c]								
6/16	86	13.4	6.0	57	108	9.7	10.8	10
6/17 [c]								
6/18	85	17.6	5.8	79	108		10.7	2
Total				5,790				6,704
Mean	91		7.0		109		11.3	

[a] Length-weight parameters by age group and discriminating length used to seperate ages from May 20 to June 18 were:

Age 1. a = - 10.5662 b = 2.7675 r2 = 0.85 n = 1,102
Age 2. a = - 9.9442 b = 2.6297 r2 = 0.81 n = 1,203

Discriminating Length = 100.86 mm

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

[c] Fyke net not set.

Table 20. Depth of sockeye salmon smolt passage at Naknek River sonar site, May 20 to June 19, 1994.

	Depth of Passage (cm)							
	Inshore Array[a] Smolt Schools		Center Array[b] Smolt Schools		Offshore Array[c] Smolt Schools		All Combined Smolt Schools	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Mean	13	78	17	76	26	87	19	80
Minimum	0	20	0	15	0	20	0	15
Maximum	115	210	80	228	115	228	115	228
n	54	54	84	84	57	57	195	195

[a] Average depth of inshore array at 0700 hours on smolt day 6/07 was 384 cm.

[b] Average depth of center array at 0700 hours on smolt day 6/07 was 361 cm.

[c] Average depth of offshore array at 0700 hours on smolt day 6/07 was 328 cm.

Table 21. Climatological and hydrological observations made at sockeye salmon smolt counting site at 0800 and 2000 hours, Naknek River, 1994.

Date	Cloud Cover[a] 0800	Cloud Cover[a] 2000	Wind Velocity (km/h) 0800	Wind Velocity (km/h) 2000	Air Temp. (°C) 0800	Air Temp. (°C) 2000	Water Temp. (°C) 0800	Water Temp. (°C) 2000	Precipitation (mm)	Water Clarity[b]
5/19	3	1	-	24 S	-	10.0	8.5	8.8	trace	glacial
5/20	4	3	13 NE	24-32 NE	6.0	10.0	9.0	8.8	trace	clear
5/21	4	3	16 NE	16 NE	7.5	8.0	9.0	8.8	0.0	clear
5/22	4	-	16-24 NE	-	9.0	-	9.0	-	-	clear
5/23	3	-	8-16 NE	-	6.0	-	8.0	-	-	glacial
5/24	2	4	0-08 NE	0-08 NE	6.0	6.5	9.0	8.5	11.4	clear
5/25	4	3	0	08 NW	6.0	8.5	9.0	8.5	14.2	clear
5/26	3	3	08 S	16-24 SE	5.0	12.0	8.0	8.3	-	clear
5/27	2	2	0	08 NW	4.0	18.0	7.5	-	0.0	clear
5/28	4	4	13 S	08 S	8.0	9.0	9.0	9.0	5.1	clear
5/29	1	4	0	40 S	6.5	7.0	9.0	9.0	0.5	clear
5/30	4	3	08 S	0-08 var	4.0	10.0	9.0	9.5	0.8	clear
5/31	1	2	05 NW	8-13 NE	8.0	13.0	9.0	10.0	-	clear
6/01	5	1	11 SE	16 SE	5.0	12.0	9.5	10.0	-	clear
6/02	4	3	0	0	5.0	11.0	9.5	10.0	0.8	clear
6/03	5	2	11 S	08 S	6.0	10.0	9.5	10.0	0.8	clear
6/04	5	3	05 S	08-16 S	5.0	11.0	9.5	11.0	-	clear
6/05	4	2	0	16-24 SE	10.0	17.0	11.0	12.0	-	clear
6/06	2	2	0	5-11 SE	10.0	12.0	11.0	13.0	-	clear
6/07	3	4	0	19 E	6.6	10.0	8.3	11.5	-	clear
6/08	4	4	3-13 E	0	10.0	14.0	8.3	12.0	trace	lt brown
6/09	2	3	0	0	11.0	16.0	8.3	12.0	-	clear
6/10	3	2	0	08 S	10.0	-	7.7	13.0	-	clear
6/11	2	3	08 E	0	8.0	15.0	10.0	12.0	trace	clear
6/12	3	4	0	8-16 S	10.0	13.0	11.0	12.5	-	clear
6/13	4	1	08 SE	5-13 SE	7.5	18.0	11.0	13.5	-	clear
6/14	4	4	10-13 E	19 S	9.0	10.0	8.3	12.0	-	clear
6/15	4	4	8-11 SE	8-16 S	5.0	7.0	7.7	7.0	-	clear
6/16	4	2	16-24 SE	-	5.0	21.0	7.7	13.0	-	clear
6/17	5	1	8-16 SE	16-32 S	8.5	17.0	10.0	15.0	-	clear
6/18	4	1	8-16 E	5-10 SW	6.0	16.0	11.0	14.0	-	clear
6/19	4	4	0	0-03 S	12.0	12.0	11.5	13.0	2.5	clear
6/20	4	-	0	-	10.0	-	12.0	-	2.5	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

[b] Water clarity at 0800 hours

Table 22. Water temperatures at sockeye salmon smolt counting site, Naknek River, 1967-1994.

Year	Sample Period	Water Temperature (°C) Minimum	Maximum	Mean
1967	May 27 - Jul 11	10.6	15.0	13.0
1968	May 21 - Jul 14	7.2	16.7	12.9
1969	May 27 - Jul 16	6.7	13.9	11.0
1970	May 27 - Jun 16	11.1	14.4	12.1
1971	Jun 07 - Jul 07	4.4	10.0	7.2
1972	Jun 08 - Jul 06	6.7	14.4	10.1
1973	May 29 - Jun 26	6.9	15.9	11.1
1974	May 21 - Jun 27	8.1	14.3	12.1
1975	May 28 - Jul 09	3.5	13.2	9.0
1976	May 22 - Jun 26	4.6	12.8	9.5
1982	May 21 - Jul 10	5.0	14.4	8.9
1983	May 20 - Jul 06	8.0	16.0	12.8
1984	May 19 - Jul 06	7.5	16.0	13.0
1985	May 21 - Jul 03	6.5	16.0	10.5
1986	May 23 - Jun 28	8.5	13.0	10.4
1993	May 17 - Jun 20	9.0	16.0	12.1
	Mean	7.1	14.5	11.0
1994	May 19 - Jun 20	7.0	15.0	10.0

Table 23. Sonar counts recorded from three arrays at the sockeye salmon smolt counting site on Egegik River, 1994.

Smolt Day [a]	Sonar Count by Transducer Array			
	Inshore	Center	Offshore	Total
5/21 [b]	2,224	6,744	6,060	15,028
5/22	29,327	15,211	5,483	50,021
5/23	98,260	246,850	211,721	556,831
5/24	58,382	161,404	178,759	398,545
5/25	44,538	170,892	73,400	288,830
5/26	146,115	143,479	36,809	326,403
5/27 [c]	11,398	60,854	115,514	187,766
5/28	1,227	12,986	45,461	59,674
5/29	96,738	60,083	104,618	261,439
5/30 [d]	240,625	110,637	205,316	556,578
5/31 [c]	248,438	514,690	182,223	945,351
6/01	4,025	28,103	48,488	80,616
6/02	37,572	96,487	91,823	225,882
6/03 [c d]	40,327	71,722	163,753	275,802
6/04	213,685	437,787	141,761	793,233
6/05 [d]	490,620	173,414	27,376	691,410
6/06	202,163	120,562	60,696	383,421
6/07	51,830	50,092	34,092	136,014
6/08	4,817	11,483	16,688	32,988
6/09 [c]	3,502	6,006	2,398	11,906
Total	2,025,813	2,499,486	1,752,439	6,277,738
Percent	32.3	39.8	27.9	

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

[b] Fyke net set at 0141 hours on May 22 captures 100 sockeye salmon smolt and confirms the presence of low numbers of smolt (CPUE=6) in the river.

[c] Data interpolated for one or more arrays on the following hours:

1500 hours on May 27 due to water velocity measurements
1300–1400 hours on May 31 due to solar panels overcharging the smolt counter
1700 hours on June 3 due to readjustment of the arrays
1300–1400 hours on June 9 due to water velcity measurements

[d] Fyke net catches confirm the presence of large numbers of smolt in the river on the following dates and times:

0024–0026 hours on May 30, fyke net CPUE=150
0132–0133 hours on June 3, fyke net CPUE=200
0059–0100 and 0105–0106 hours on June 5, fyke net CPUE=200

Table 24. Daily number of sockeye salmon smolt emigrating seaward estimated with hydroacoustic equipment, Egegik River, 1994.

	Age 1.			Age 2.			Age 3.			All Ages	
Smolt Day [a]	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5/21	96,337	46.6	96,337	110,351	53.4	110,351				206,688	206,688
5/22	337,276	46.6	433,613	386,337	53.4	496,688				723,613	930,301
5/23	3,545,205	46.6	3,978,818	4,060,899	53.4	4,557,587				7,606,104	8,536,405
5/24	2,363,966	44.0	6,342,784	3,009,906	56.0	7,567,493				5,373,872	13,910,277
5/25	1,184,876	34.3	7,527,660	2,267,560	65.7	9,835,053				3,452,436	17,362,713
5/26	1,430,711	34.3	8,958,371	2,738,028	65.6	12,573,081				4,168,739	21,531,452
5/27	1,520,955	53.4	10,479,326	1,329,945	46.7	13,903,026				2,850,900	24,382,352
5/28	715,242	69.2	11,194,568	317,896	30.8	14,220,922				1,033,138	25,415,490
5/29	3,323,526	73.9	14,518,094	1,173,802	26.1	15,394,724				4,497,328	29,912,818
5/30	4,988,696	56.8	19,506,790	3,795,766	43.2	19,190,490				8,784,462	38,697,280
5/31	8,963,053	63.1	28,469,843	5,238,517	36.8	24,429,007	14,215	0.1	14,215	14,215,785	52,913,065
6/01	607,684	49.4	29,077,527	621,450	50.6	25,050,457			14,215	1,229,134	54,142,199
6/02	2,574,912	71.9	31,652,439	1,003,026	28.0	26,053,483	3,940	0.1	18,155	3,581,878	57,724,077
6/03	2,912,751	66.3	34,565,190	1,481,864	33.7	27,535,347			18,155	4,394,615	62,118,692
6/04	7,112,799	62.0	41,677,989	4,359,457	38.0	31,894,804			18,155	11,472,256	73,590,948
6/05	6,788,587	60.5	48,466,576	4,435,928	39.5	36,330,732			18,155	11,224,515	84,815,463
6/06	4,387,146	69.4	52,853,722	1,931,658	30.6	38,262,390			18,155	6,318,804	91,134,267
6/07	1,587,508	70.7	54,441,230	657,271	29.3	38,919,661			18,155	2,244,779	93,379,046
6/08	334,631	64.2	54,775,861	185,234	35.6	39,104,895	1,041	0.2	19,196	520,906	93,899,952
6/09	133,189	71.2	54,909,050	53,848	28.8	39,158,743			19,196	187,037	94,086,989
	54,909,050	58.4		39,158,743	41.6		19,196	0.0		94,086,989	

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

Table 25. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Egegik River, 1994.

Smolt Day [a]	Mean Weight of Smolt (g)	Smolt per Count
5/21	12.5	3.3
5/22	12.5	3.3
5/23	12.5	3.3
5/24	12.8	3.3
5/25	13.6	3.0
5/26	13.6	3.0
5/27	11.9	3.5
5/28	10.8	3.8
5/29	10.6	3.9
5/30	11.7	3.6
5/31	11.2	3.7
6/01	11.8	3.5
6/02	10.6	3.9
6/03	11.1	3.8
6/04	11.5	3.6
6/05	11.3	3.7
6/06	10.9	3.8
6/07	10.6	3.9
6/08	11.0	3.8
6/09	10.5	4.0

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

Table 26. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production composed by each age class, and number of smolt produced per spawner for 1978-1992 brood years, Egegik River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age 1. (%)[a]	Age 2. (%)[a]	Age 3.	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)	0	63,469,761	55.13
1987	1,272,978	72,458,024 (58)	52,299,487 (42)	396,423	125,153,934	98.32
1988	1,612,680	3,795,739 (4)	89,162,038 (96)	361,128	93,318,905	57.87
1989	1,610,916	4,519,527 (21)	17,338,786 (79)	37,254	21,895,567	13.59
1990	2,191,362	6,048,364 (14)	37,719,609 (86)	19,196	43,787,169	19.98
1991	2,786,880	20,203,545 (34)	39,158,743 (66)		59,362,288[b]	21.30[b]
1992	1,945,332	54,909,050				
Max 80-89	1,612,680	72,458,024	89,162,038	396,423	125,153,934	106.85
Avg 80-89	1,149,086	25,882,895	33,447,188	129,282	59,459,365	53.83
Min 80-89	694,680	2,242,326	11,434,848	0	17,236,372	13.59

[a] Percent of total smolt production

[b] Preliminary total

Table 27. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1978-1992 brood years, Egegik River.

Brood Year	Total Spawning Escapement	Age 1. Number of Smolt	Age 1. Adult[a] Returns	Age 1. Adult Returns per Smolt	Age 2. Number of Smolt	Age 2. Adult[a] Returns	Age 2. Adult Returns per Smolt	Age 3. Number of Smolt	Age 3. Adult[a] Returns	Age 3. Adult Returns per Smolt
1978	895,698	-	908,379		-	8,264,740		225,522	33,395	0.15
1979	1,032,042	-	1,239,273		14,287,075	4,705,018	0.33	0	0	0.00
1980	1,060,860	49,457,563	3,035,494	0.06	16,524,563	5,519,025	0.33	197,429	7,730	0.04
1981	694,680	2,242,326	1,508,516	0.67	32,235,734	4,785,803	0.15	52,852	16,119	0.30
1982	1,034,628	17,234,269	2,873,325	0.17	11,434,848	3,447,534	0.30	564	12,739	[b]
1983	792,282	54,585,828	4,520,747	0.08	29,984,140	6,085,720	0.20	85,087	37,329	0.44
1984	1,165,320	14,016,441	1,596,859	0.11	45,386,536	11,482,531	0.25	80,931	249,131	[b]
1985	1,095,192	4,397,087	1,951,334	0.44	12,758,135	5,558,244	0.44	81,150	26,295	0.32
1986	1,151,320	36,122,149	5,664,220	0.16	27,347,612	8,549,130	0.31	0	116,845	[b]
1987	1,272,978	72,458,024	5,550,526	0.08	52,299,487	20,140,758	0.39	396,423	201,328	0.51[c]
1988	1,612,680	3,795,739	1,910,599	0.50	89,162,038	16,777,559	0.19[c]	361,128	255,595	0.71[c]
1989	1,610,916	4,519,527	1,060,534	0.23[c]	17,338,786	6,121,953	0.35[c]	37,245	1,038	0.03[c]
1990	2,191,362	6,048,364	405,559	0.07[c]	37,719,609	65,770	0.00[c]	19,196		
1991	2,786,880	20,203,545	1,038	0.00[c]	39,158,743					
1992	1,945,332	54,909,050								
Max	2,786,880	72,458,024	5,664,220	0.67	89,162,038	20,140,758	0.39	396,423	249,131	0.71
Avg	1,356,145	26,153,070	2,796,297	0.25	32,741,331	7,353,850	0.26	118,271	55,509	0.31
Min	694,680	2,242,326	908,379	0.06	11,434,848	558,244	0.04	0	0	0.03

[a] Includes estimates of returns through 1993.

[b] Insufficient Age 3. smolt sampled to perform this calculation.

[c] Future adult returns will increase these values.

Table 28. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Egegik River, 1994.

	Age 1.					Age 2.					Age 3.				
Smolt Day [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
5/21	104	11.4	10.4	3.06	30	121	24.3	15.8	8.57	67					0
5/22	106	6.0	10.2	1.75	30	122	23.9	15.0	9.15	70					0
5/23	106	12.0	10.0	4.23	47	121	21.7	14.1	8.39	52					0
5/24	106	10.2	9.5	2.89	50	124	18.7	14.8	7.72	50					0
5/25	104	10.1	8.9	2.75	50	122	19.5	14.4	6.92	50					0
5/26	106	10.3	10.1	3.29	37	126	19.6	16.5	7.46	62					0
5/27	104	8.3	9.2	2.51	61	120	17.2	13.7	5.85	39					0
5/28	104	12.0	9.4	3.60	78	114	11.0	12.1	3.50	22					0
5/29	104	11.3	9.2	3.43	80	117	16.8	13.3	4.92	20					0
5/30	104	15.0	9.5	3.79	71	120	21.1	14.6	8.30	29					0
5/31	103	11.8	9.3	2.94	61	116	16.5	12.9	5.27	38	122		12.4		1
6/01	105	9.4	10.0	2.92	58	116	12.0	12.8	3.95	41					0
6/02	103	12.1	9.4	3.41	77	115	18.4	12.5	5.13	21	130		16.3		1
6/03	103	10.8	9.7	3.25	71	116	17.1	13.3	5.25	27					0
6/04	103	10.7	10.0	3.17	65	119	22.8	14.1	7.85	35					0
6/05	102	15.9	9.7	4.73	68	116	19.9	13.0	6.11	31					0
6/06	105	12.7	10.2	3.56	71	113	20.5	12.7	6.40	29					0
6/07	101	13.7	9.2	4.08	73	115	20.9	13.1	5.97	27					0
6/08	102	14.4	9.0	4.45	72	120	21.4	14.0	7.44	27	123		15.1		1
6/09	101	12.5	8.3	3.82	84	114	22.0	12.0	7.12	13					0
Total					1,234					750					3
Mean	104		9.6			118		13.7			125		14.6		

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

Table 29. Age composition of total migration and mean fork length and weight by age class for sockeye salmon smolt, Egegik River, 1939-1994.

	Age 1.				Age 2.				Age 3.				
Year of Migration	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Total Estimate [a]
1939	1937	-	96	-	1936	-	105	-	1935	-	-	-	-
1956	1954	-	101	-	1953	-	116	-	1952	-	123	-	-
1957	1955	-	107	-	1954	-	120	-	1953	-	130	-	-
1959	1957	-	99	-	1956	-	116	-	1955	-	123	-	-
1960	1958	-	106	-	1957	-	115	-	1956	-	140	-	-
1969	1967	-	99	-	1966	-	119	-	1965	-	115	-	-
1977	1975	-	110	11.3	1974	-	116	13.3	1973	-	-	-	-
1978	1976	-	104	10.1	1975	-	122	15.4	1974	-	130	18.1	-
1981	1979	-	105	9.1	1978	-	122	16.6	1977	-	128	19.1	-
1982	1980	77	104	9.2	1979	23	130	17.1	1978	0	145	23.5	63,970,160
1983	1981	12	101	9.3	1980	88	116	13.6	1979	0	-	-	18,766,889
1984	1982	35	106	10.1	1981	65	112	12.2	1980	0	134	20.2	49,667,432
1985	1983	83	106	10.4	1982	17	123	16.8	1981	0	138	24.1	66,073,548
1986	1984	32	101	9.0	1983	68	122	15.7	1982	0	140	22.6	44,197,865
1987	1985	9	107	11.6	1984	91	114	14.1	1983	0	128	18.9	49,868,710
1988	1986	74	103	10.2	1985	26	117	14.3	1984	0	136	21.2	48,961,215
1989	1987	73	99	8.9	1986	27	119	15.4	1985	0	135	21.1	99,886,786
1990	1988	7	102	9.6	1987	93	118	14.5	1986	0	-	-	56,095,226
1991	1989	5	102	10.3	1988	95	118	15.6	1987	0	140	24.4	94,095,226
1992	1990	26	104	10.2	1989	73	112	12.4	1988	1	127	17.6	23,748,278
1993	1991	35	102	9.3	1990	65	112	12.2	1989	0	138	22.1	57,960,399
Mean			102	9.7			117	14.3			125	21.1	
1994	1992	58	104	9.6	1991	42	118	13.7	1990	0	125	14.6	94,086,989

[a] No estimates of smolt numbers from 1939-1981 fyke net catches; estimates of smolt numbers for 1982-1994 based on hydroacoustic techniques.

Table 30. Mean fork length and estimated mean weight for age-1. and -2. sockeye salmon smolt, Egegik River, 1994.

Smolt Day [b]	Estimated Age 1. [a] Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size	Estimated Age 2. [a] Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size
5/21	107	6.6	10.2	37	123	21.0	15.0	62
5/22	107	5.0	10.3	22	124	19.3	15.4	42
5/23	105	14.4	9.7	353	120	27.7	14.1	278
5/24	105	13.2	9.7	264	123	33.2	15.2	327
5/25	104	10.9	9.5	124	122	23.3	14.8	75
5/26	105	12.3	9.8	171	125	35.5	15.9	445
5/27	105	14.7	9.7	331	121	31.0	14.5	267
5/28	104	15.1	9.5	401	117	21.6	13.3	134
5/29	103	16.5	9.4	443	118	21.3	13.6	111
5/30	103	16.4	9.4	323	121	28.6	14.4	235
5/31	103	16.9	9.4	403	119	26.1	14.0	199
6/01	104	12.7	9.6	220	118	22.8	13.5	207
6/02	103	16.7	9.3	455	118	22.6	13.4	132
6/03	103	16.3	9.4	424	119	24.6	13.9	183
6/04	103	16.3	9.4	404	121	29.2	14.6	207
6/05	103	16.7	9.4	359	119	26.3	14.0	208
6/06	103	15.7	9.3	417	118	23.6	13.6	136
6/07	102	19.3	9.1	434	118	22.5	13.7	128
6/08	101	15.9	8.9	253	120	21.5	14.3	94
6/09	101	10.4	8.9	90	115	9.5	12.6	10
Total				5,928				3,480
Mean	104		9.5		120		14.2	

[a] Length-weight parameters by age group and discriminating length used to seperate ages from May 21 to June 10 were:

Age 1. $a = -9.5206$ $b = 2.5327$ $r^2 = 0.59$ $n = 1,234$
Age 2. $a = -10.0820$ $b = 2.6557$ $r^2 = 0.80$ $n = 750$

Discriminating Length = 110.28

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

Table 31. Depth of sockeye salmon smolt passage at Egegik River sonar site, May 23 to June 7, 1994.

	Depth of Passage (cm)							
	Inshore Array[a] Smolt Schools		Center Array[b] Smolt Schools		Offshore Array[c] Smolt Schools		All Combined Smolt Schools	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Mean	73	205	58	230	51	217	61	217
Minimum	0	1	0	39	0	42	0	1
Maximum	203	335	210	400	199	406	210	406
n	35	35	41	41	45	45	121	121

[a] Average depth of inshore array at 1800 hours on smolt day 5/31 was 325 cm.

[b] Average depth of center array at 1800 hours on smolt day 5/31 was 385 cm.

[c] Average depth of offshore array at 1800 hours on smolt day 5/31 was 401 cm.

Table 32. Climatological and hydrological observations made at sockeye salmon smolt counting site at 0800 and 2000 hours, Egegik River, 1994.

Date	Cloud Cover[a] 0800	Cloud Cover[a] 2000	Wind Velocity (km/h) 0800	Wind Velocity (km/h) 2000	Air Temp. (°C) 0800	Air Temp. (°C) 2000	Water Temp. (°C) 0800	Water Temp. (°C) 2000	Precipitation (mm)	Water Clarity[b]
5/21	4	3	0	24 E	5.6	5.6	3.0	5.0	0.0	clear
5/22	4	3	0	32-40 N	5.6	7.8	4.0	5.0	0.8	clear
5/23	2	3	5 SE	8 SE	5.6	13.3	3.0	6.0	0.5	clear
5/24	4	3	5 E	16 SW	5.6	10.0	4.0	7.0	0.0	clear
5/25	4	3	0	8 SE	6.7	10.0	5.0	6.5	0.5	clear
5/26	1	3	8-16 E	40 E	4.4	7.8	4.0	6.8	0.0	clear
5/27	3	2	8-16 E	16-24 W	5.6	10.0	4.0	7.0	0.0	clear
5/28	4	3	8 SE	32 WSW	6.7	7.2	5.0	6.0	2.0	clear
5/29	1	3	0	32-40 WSW	7.8	7.2	5.0	7.0	0.3	clear
5/30	4	3	8 S	0-05 NNW	5.6	10.0	4.0	5.0	0.0	clear
5/31	2	3	0	8-16 SE	6.7	10.6	4.0	7.5	0.0	clear
6/01	4	4	8-16 S	8 SW	5.6	7.8	4.0	7.0	0.0	clear
6/02	4	3	0	0-03 NW	5.6	13.3	5.0	7.5	1.5	clear
6/03	5	3	8 S	8-16 SW	4.4	11.4	5.0	8.5	0.3	clear
6/04	5	1	0	16-24 SE	5.6	13.9	5.0	8.5	0.0	clear
6/05	4	2	8-16 SE	40-48 SE	6.7	10.0	5.5	8.0	0.0	clear
6/06	1	2	8 E	32-40 SE	6.7	15.0	5.0	8.5	0.0	clear
6/07	4	4	0	8-16 SE	6.7	8.9	5.0	6.0	5.3	clear
6/08	4	3	0	24-32 SE	6.7	12.8	5.5	9.0	3.3	clear
6/09	3	3	8 E	2-05 NE	8.9	12.2	5.5	9.0	0.0	clear
6/10	4	-	0	-	8.9	-	7.0	-	-	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

[b] Water clarity at 0800 hours

Table 33. Water temperatures at sockeye salmon smolt counting site, Egegik River, 1981-1994.

Year	Sample Period	Water Temperature (°C)		
		Minimum	Maximum	Mean
1981	May 15 - Jun 08	5.0	9.0	7.3
1982	May 15 - Jun 16	0.0	5.0	2.9
1983	May 18 - Jun 10	5.0	9.5	7.0
1984	May 17 - Jun 11	5.0	10.0	7.6
1985	May 17 - Jun 12	2.5	7.5	4.2
1986	May 19 - Jun 12	2.2	7.5	7.2
1987	May 18 - Jun 13	3.9	11.0	6.6
1988	May 19 - Jun 14	3.0	10.1	6.4
1989	May 21 - Jun 10	3.0	11.0	5.2
1990	May 20 - Jun 11	2.5	10.0	5.4
1991	May 21 - Jun 12	4.0	10.0	6.4
1992	May 21 - Jun 12	3.5	10.0	6.8
1993	May 18 - Jun 09	5.0	10.0	7.2
	Mean	3.4	9.3	6.2
1994	May 21 - Jun 10	3.0	9.0	5.8

Table 34. Sonar counts recorded from two arrays at the sockeye salmon smolt counting site on Ugashik River, 1994.

Smolt Day [a]	Sonar Counts		
	Transducer Array		
	Inshore	Offshore	Total
5/20	197	1,835	2,032
5/21 [b]	4,290	16,371	20,661
5/22	2,129	7,413	9,542
5/23 [b]	6,023	17,115	23,138
5/24	3,783	24,683	28,466
5/25	8,940	48,599	57,539
5/26 [b]	14,632	40,974	55,606
5/27	39,703	76,839	116,542
5/28 [b]	6,541	11,506	18,047
5/29	8,390	16,403	24,793
5/30 [b]	7,557	46,228	53,785
5/31	157,455	125,922	283,377
6/01	22,244	73,403	95,647
6/02	41,467	195,737	237,204
6/03	46,698	104,504	151,202
6/04	63,026	483,611	746,637
6/05	98,520	239,254	337,774
6/06 [b]	16,616	99,312	115,928
6/07 [b]	73,895	530,710	604,605
6/08	33,696	110,117	143,813
6/09	13,087	44,751	57,838
6/10	10,794	34,473	45,267
6/11	1,901	2,634	4,535
6/12	2,574	4,957	7,531
Total	884,158	2,357,351	3,241,509
Percent	27.3	72.7	

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

[b] Sonar counts interpolated for one or more arrays on the following hours and dates:

1500 hours on May 21 due to sleet storm.
1700 hours, 0900-1100 hours on May 23 due to equipment modifications.
1800-0600 hours on May 26 due to entrained air from wave action.
1700-2000 hours on May 28 due to wind and rain.
1500 hours on May 30 due to boat traffic.
1500-1600 hours, 0100-0500 hours, and 0800-1100 hours on June 6 due to wind.
1200-2200 hours on June 7 due to wave action.

Table 35. Daily number of sockeye salmon smolt emigrating seaward estimated with hydroacoustic equipment, Ugashik River, 1994.

Smolt Day [a]	Age 1. Number	Age 1. Percent	Age 1. Cumulative Total	Age 2. Number	Age 2. Percent	Age 2. Cumulative Total	All Ages Daily Total	All Ages Cumulative Total
5/20	11,095	75.7	11,095	3,561	24.3	3,561	14,656	14,656
5/21	126,203	75.7	137,298	40,511	24.3	44,072	166,714	181,370
5/22	74,518	87.4	211,816	10,723	12.6	54,795	85,241	266,611
5/23	187,019	87.4	398,835	26,912	12.6	81,707	213,931	480,542
5/24	203,035	87.4	601,870	29,217	12.6	110,924	232,252	712,794
5/25	436,888	87.1	1,038,758	64,993	13.0	175,917	501,881	1,214,675
5/26	491,468	90.2	1,530,226	53,638	9.8	229,555	545,106	1,759,781
5/27	1,097,319	90.2	2,627,545	119,760	9.8	349,315	1,217,079	2,976,860
5/28	90,854	60.1	2,718,399	60,368	39.9	409,683	151,222	3,128,082
5/29	122,572	60.1	2,840,971	81,443	39.9	491,126	204,015	3,332,097
5/30	219,687	60.1	3,060,658	145,970	39.9	637,096	365,657	3,697,754
5/31	1,657,372	60.1	4,718,030	1,101,237	39.9	1,738,333	2,758,609	6,456,363
6/01	308,779	47.2	5,026,809	345,413	52.8	2,083,746	654,192	7,110,555
6/02	1,645,910	83.3	6,672,719	329,024	16.7	2,412,770	1,974,934	9,085,489
6/03	760,486	59.4	7,433,205	520,656	40.6	2,933,426	1,281,142	10,366,631
6/04	4,978,807	72.0	12,412,012	1,935,242	28.0	4,868,668	6,914,049	17,280,680
6/05	3,270,098	92.5	15,682,110	265,143	7.5	5,133,811	3,535,241	20,815,921
6/06	972,191	92.5	16,654,301	78,826	7.5	5,212,637	1,051,017	21,866,938
6/07	4,947,593	92.5	21,601,894	401,156	7.5	5,613,793	5,348,749	27,215,687
6/08	1,493,519	96.0	23,095,413	61,743	4.0	5,675,536	1,555,262	28,770,949
6/09	597,768	96.0	23,693,181	24,712	4.0	5,700,248	622,480	29,393,429
6/10	471,165	96.0	24,164,346	19,478	4.0	5,719,726	490,643	29,884,072
6/11	54,753	96.0	24,219,099	2,263	4.0	5,721,989	57,016	29,941,088
6/12	85,982	96.0	24,305,081	3,554	4.0	5,725,543	89,536	30,030,624
	24,305,081	80.9		5,725,543	19.1		30,030,624	

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

Table 36. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Ugashik River, 1994.

Smolt Day [a]	Mean Weight of Smolt (g)	Smolt per Count
5/20	7.8	5.3
5/21	7.8	5.3
5/22	7.2	5.8
5/23	7.2	5.8
5/24	7.2	5.8
5/25	6.9	6.0
5/26	6.8	6.1
5/27	6.8	6.1
5/28	8.7	4.8
5/29	8.7	4.8
5/30	8.7	4.8
5/31	8.7	4.8
6/01	9.5	4.4
6/02	7.5	5.5
6/03	8.3	5.0
6/04	7.9	5.3
6/05	6.8	6.1
6/06	6.8	6.1
6/07	6.8	6.1
6/08	6.2	6.7
6/09	6.2	6.7
6/10	6.2	6.7
6/11	6.2	6.7
6/12	6.2	6.7

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

Table 37. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production composed by each age class, and number of smolt produced per spawner for 1979-1992 brood years, Ugashik River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced							
		Age 1.	(%[a])	Age 2.	(%[a])	Age 3.	(%[a])	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)	0		214,998,421	214.68
1987	668,964	94,119,379	(71)	38,789,387	(29)	0		132,908,766	198.68
1988	642,972	14,837,960	(24)	47,713,086	(76)	-	[b]	62,551,046	97.28
1989	1,681,302	26,056,791		-	[b]	0		-	-
1990	730,038	-	[b]	12,415,518		0		-	-
1991	2,457,306	58,331,556	(91)	5,725,543	(09)			64,057,099	26.07
1992	2,173,692	24,305,081							
Max	3,321,384	182,719,678		82,656,993		26,384		214,998,421	214.68
Avg	1,435,901	51,191,339		29,421,089		3,424		85,914,878	90.01
Min	642,972	5,461,821		5,725,543		0		26,056,791	15.50

[a] Percent of total smolt production

[b] No Ugashik River smolt enumeration project conducted in 1992. Therefore smolt production data for the 1988, 1989, and 1990 brood years are incomplete because no smolt data were collected in 1992.

Table 38. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1992 brood years, Ugashik River.

		Age 1.			Age 2.			Age 3.		
Brood Year	Total Spawning Escapement	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	-	3,960,210		-	2,045,642		-	0	[d]
1980	3,321,384	-	3,503,629		12,736,379	4,262,289	0.33	26,384	2,600	0.10
1981	1,326,762	31,297,432	4,241,375	0.14	82,656,993	3,215,237	0.04	0	1,682	[d]
1982	1,157,526	75,491,249	1,146,491	0.02	21,407,762	1,345,244	0.06	0	0	[d]
1983	1,000,614	12,693,628	995,579	0.08	15,186,101	957,859	0.06	1,677	957	0.57
1984	1,241,418	37,890,152	1,052,811	0.03	21,483,727	4,394,930	0.20	9,598	5,707	0.59
1985	998,232	5,461,821	1,233,687	0.23	33,238,739	1,465,357	0.04	0	0	[d]
1986	1,001,493	182,719,678	3,055,686	0.03	32,278,743	3,681,875	0.11	0	4,478	[d]
1987	668,964	94,019,379	2,501,539	0.03	38,789,387	4,271,781	0.11	0	34,988	[d]
1988	642,972	14,837,960	1,204,275	0.08	47,713,086	4,472,368	0.09[b]	-[c]	21,803	[d]
1989	1,681,302	26,056,791	1,105,637	0.04[b]	-[c]	2,484,553	[d]	0	0	
1990	730,038	-[c]	348,398	[d]	12,415,518	14,860		0		
1991	2,457,306	58,331,556	6,303		5,725,543					
1992	2,173,692	24,305,081								
Max	3,321,384	182,719,678	4,241,375	0.23	82,656,993	4,394,930	0.33	26,384	5,707	0.57
Avg	1,435,901	51,191,339	2,289,528	0.08	29,421,089	2,848,913	0.12	3,766	1,928	0.33
Min	642,972	5,461,821	995,579	0.02	5,725,543	957,859	0.04	0	0	0.10

[a] Includes estimates of returns through 1994.

[b] Future adult returns will increase these values.

[c] No Ugashik River smolt enumeration project conducted in 1992. Therefore smolt estimates for the 1988, 1989, and 1990 brood years are incomplete because no smolt data were collected in 1992.

[d] Insufficient smolt data to complete this calculation.

Table 39. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Ugashik River, 1994.

	Age 1.					Age 2.				
Smolt Day [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
5/21	89	13.3	6.9	2.96	76	112	8.7	12.0	2.94	24
5/24	87	11.2	7.2	2.55	93	110	7.2	11.2	1.95	7
5/25	87	10.4	5.2	2.54	93	110	5.8	10.1	1.38	7
5/27	88	11.0	6.2	3.03	87	112	13.2	12.2	4.17	13
5/30	91	8.2	7.5	2.00	32	110	14.3	12.2	4.62	67
5/31	89	7.8	6.8	1.89	83	107	10.1	11.0	3.16	15
6/01	91	6.3	7.5	3.12	17	113	16.5	12.9	5.60	81
6/02	90	13.3	7.6	3.32	83	105	10.4	10.5	2.64	17
6/03	90	7.3	6.6	1.63	47	106	14.1	10.2	4.24	53
6/04	90	12.8	6.7	3.01	63	106	13.8	10.7	3.65	37
6/05	88	12.5	6.5	2.21	64	111	7.4	12.0	2.70	6
6/07	87	15.0	6.3	3.75	94	104	10.1	9.9	3.41	7
6/08	85	12.2	6.1	2.60	96	111	7.4	11.4	3.08	4
Total					928					338
Mean	89		6.7			109		11.2		

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

Table 40. Age composition of total migration and mean fork length and weight by age class for sockeye salmon smolt, Ugashik River, 1958-1994.

	Age 1.				Age 2.				Age 3.				
Year of Migration	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Brood Year	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Total Estimate *
1958	1956	-	93	6.4	1955	-	112	11.7	1954	-	-	-	-
1959	1957	-	90	6.1	1956	-	120	13.5	1955	-	-	-	-
1960	1958	-	90	6.6	1957	-	104	11.0	1956	-	-	-	-
1961	1959	-	90	6.7	1958	-	112	12.2	1957	-	-	-	-
1962	1960	-	88	6.1	1959	-	112	12.3	1958	-	-	-	-
1963	1961	-	90	6.1	1960	-	104	9.6	1959	-	-	-	-
1964	1962	-	92	6.9	1961	-	118	12.7	1960	-	-	-	-
1965	1963	-	94	6.9	1962	-	114	12.5	1961	-	-	-	-
1967	1965	-	88	6.0	1964	-	113	12.2	1963	-	-	-	-
1968	1966	-	93	6.5	1965	-	113	10.7	1964	-	-	-	-
1969	1967	-	97	7.5	1966	-	121	14.5	1965	-	-	-	-
1970	1968	-	97	7.7	1967	-	125	15.9	1966	-	-	-	-
1972	1970	-	81	5.0	1969	-	112	11.2	1968	-	129	14.3	-
1973	1971	-	93	7.2	1970	-	113	11.9	1969	-	132	20.1	-
1974	1972	-	94	7.4	1971	-	119	13.6	1970	-	-	-	-
1975	1973	-	96	7.2	1972	-	116	13.0	1971	-	125	16.7	-
1982	1980	-	88	6.3	1979	-	113	13.0	1978	-	138	22.5	-
1983	1981	71	89	7.6	1980	29	111	13.2	1979	-	-	-	44,033,811

-Continued-

Table 40. (p 2 of 2)

Year of Migration	Age 1. Brood Year	Age 1. Percent of Total Estimate	Age 1. Mean Length (mm)	Age 1. Mean Weight (g)	Age 2. Brood Year	Age 2. Percent of Total Estimate	Age 2. Mean Length (mm)	Age 2. Mean Weight (g)	Age 3. Brood Year	Age 3. Percent of Total Estimate	Age 3. Mean Length (mm)	Age 3. Mean Weight (g)	Total Estimate [a]
1984	1982	48	87	6.8	1981	52	102	10.3	1980	0	103	11.7	158,174,626
1985	1983	37	94	8.3	1982	63	107	11.8	1981	-	-	-	34,101,390
1986	1984	71	87	5.8	1983	29	114	10.9	1982	-	-	-	53,076,253
1987	1985	20	94	7.9	1984	80	107	11.1	1983	0	138	24.1	26,947,225
1988	1986	85	87	5.7	1985	15	109	10.8	1984	0	128	15.6	215,968,015
1989	1987	74	90	6.5	1986	26	108	10.7	1985	-	-	-	126,298,122
1990	1988	28	90	6.7	1987	72	108	11.8	1986	-	-	-	53,627,347
1991	1989	35	92	7.7	1988	65	107	11.6	1987	-	-	-	73,769,877
1992 [b]	1990	-	-	-	1989	-	-	-	1988	-	-	-	-
1993	1991	83	92	8.0	1990	17	109	12.5	1989	-	-	-	70,747,074
Mean			91	6.8			112	12.1			128	17.9	
1994	1992	81	89	6.7	1991	19	109	11.2	1990	-	-	-	30,030,624

[a] No estimates of smolt numbers from 1958-1982 fyke net catches; estimates of smolt numbers for 1983-1991 and 1993-1994 based on hydroacoustic techniques.

[b] Project not operated in 1992. No smolt data collected.

Table 41. Mean fork length and estimated mean weight for age-1. and -2. sockeye salmon smolt, Ugashik River, 1994.

Smolt Day [b]	Estimated Age 1.[a] Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size	Estimated Age 2.[a] Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size
5/21	88	17.1	6.5	430	110	18.4	11.7	140
5/24	88	14.5	6.5	464	108	15.6	11.1	65
5/25	87	17.4	6.4	470	109	15.0	11.4	69
5/27	87	18.0	6.3	496	108	12.5	11.1	39
5/30	91	9.9	7.0	94	111	19.1	12.1	159
5/31	89	16.3	6.7	573	107	17.4	11.0	197
6/01	90	14.0	6.9	255	110	22.7	11.7	302
6/02	90	19.1	6.9	510	106	16.7	10.6	100
6/03	89	17.0	6.7	320	106	19.8	10.7	236
6/04	90	19.2	6.9	407	105	17.5	10.4	152
6/05	87	16.8	6.4	135	106	9.6	10.5	13
6/07	87	20.1	6.4	503	105	12.2	10.5	25
6/08	85	19.6	5.9	552	108	11.5	11.1	5
Total				5,209				1,502
Mean	88		6.6		108		11.1	

[a] Length-weight parameters by age group and discriminating length used to seperate ages were:

Age 1. a = -9.9744 b = 2.6421 r2 = 0.51 n = 928
Age 2. a = -10.3542 b = 2.7229 r2 = 0.80 n = 338

Discriminating Length = 98.38 mm

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

Table 42. Depth of sockeye salmon smolt passage at Ugashik River sonar site, May 22 to June 10, 1994.

	Depth of Passage (cm)					
	Inshore Array[a] Smolt Schools		Offshore Array[b] Smolt Schools		All Combined Smolt Schools	
	Top	Bottom	Top	Bottom	Top	Bottom
Mean	12	95	13	94	12	95
Minimum	0	45	0	32	0	32
Maximum	50	218	55	168	55	218
n	25	25	30	30	55	55

[a] Average depth of inshore array at 2400 hours on smolt day 6/04 was 294 cm.

[b] Average depth of offshore array at 2400 hours on smolt day 6/04 was 318 cm.

Table 43. Climatological and hydrological observations made at sockeye salmon smolt counting site at 0800 and 2000 hours, Ugashik River, 1994.

Date	Cloud Cover [a] 0800	Cloud Cover [a] 2000	Wind Velocity (km/h) 0800	Wind Velocity (km/h) 2000	Air Temp (°C) 0800	Air Temp (°C) 2000	Water Temp (°C) 0800	Water Temp (°C) 2000	Percipitation (mm)	Water Clarity [b]
5/20	3	3	-	16 SE	9.0	12.0	5.0	6.7	-	lt brown
5/21	3	3	0	16 SE	5.0	5.0	5.0	5.6	trace	lt brown
5/22	3	4	8 E	8 E	6.0	6.0	5.0	5.6	0.0	lt brown
5/23	3	3	8 E	3 SE	5.0	7.0	5.0	6.0	0.0	lt brown
5/24	3	4	0	16 W	5.0	5.0	6.0	5.0	0.0	clear
5/25	4	2	0	8 W	4.0	11.0	5.0	6.0	trace	clear
5/26	3	3	5 SE	32 SE	4.0	5.0	6.0	7.0	trace	clear
5/27	3	1	8 SE	5 W	6.5	7.0	7.0	7.5	0.0	clear
5/28	4	4	5 SE	48 W	5.0	5.0	6.0	6.0	12.7	clear
5/29	1	4	11 W	25-56 WSW	6.5	3.0	5.0	5.0	trace	clear
5/30	4	3	3 W	8 WSW	1.0	9.0	4.5	5.0	12.7	clear
5/31	3	3	2 SW	24 S	16.0	8.0	5.0	6.0	trace	clear
6/01	4	4	8 SW	8 W	2.0	5.0	5.5	6.0	0.0	clear
6/02	4	3	3 E	16 S	2.0	10.0	5.0	6.5	trace	clear
6/03	5	4	3 S	24 SW	3.0	5.0	5.5	6.0	trace	clear
6/04	4	1	2 W	13 SE	3.0	11.0	6.0	8.0	0.0	clear
6/05	2	2	8 SE	32 SE	7.0	8.0	8.0	10.0	0.0	clear
6/06	2	3	24 SE	32 SE	7.0	8.0	8.0	8.5	0.0	lt brown
6/07	4	4	16 E	16 SE	7.0	7.5	7.0	8.0	trace	lt brown
6/08	3	3	5 SE	8 S	7.0	8.5	7.5	9.0	trace	clear
6/09	2	3	16 E	16 SE	8.0	9.5	7.5	8.0	0.0	clear
6/10	4	1	3 S	3 SE	13.0	10.5	8.0	9.5	trace	clear
6/11	2	4	0	11 W	14.0	10.0	8.0	8.0	25.4	clear
6/12	4	4	8 S	16 S	7.0	7.5	7.0	7.5	6.4	clear
6/13	4	-	16 S	-	6.0	-	7.0	-	trace	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

[b] Water clarity at 0800 hours

Table 44. Water temperatures at sockeye salmon smolt counting site, Ugashik River, 1983-1994.

Year	Sample Period	Water Temperature (°C) Minimum	Maximum	Mean
1983	May 23 - Jun 11	6.0	8.5	7.3
1984	May 20 - Jun 17	4.8	8.0	6.3
1985	May 17 - Jun 09	-1.0	7.0	4.3
1986	May 23 - Jun 28	2.0	7.0	5.6
1987	May 17 - Jun 13	4.0	9.0	5.9
1988	May 17 - Jun 13	3.5	10.0	6.6
1989	May 21 - Jun 16	3.0	8.8	5.8
1990	May 21 - Jun 14	3.0	8.0	5.9
1991	May 20 - Jun 14	4.0	8.5	5.9
1992[a]	-	-	-	-
1993	May 18 - Jun 11	5.0	9.0	7.3
	Mean	3.4	8.4	6.0
1994	May 20 - Jun 13	4.5	10.0	6.5

[a] Project not operated in 1992, no data collected.

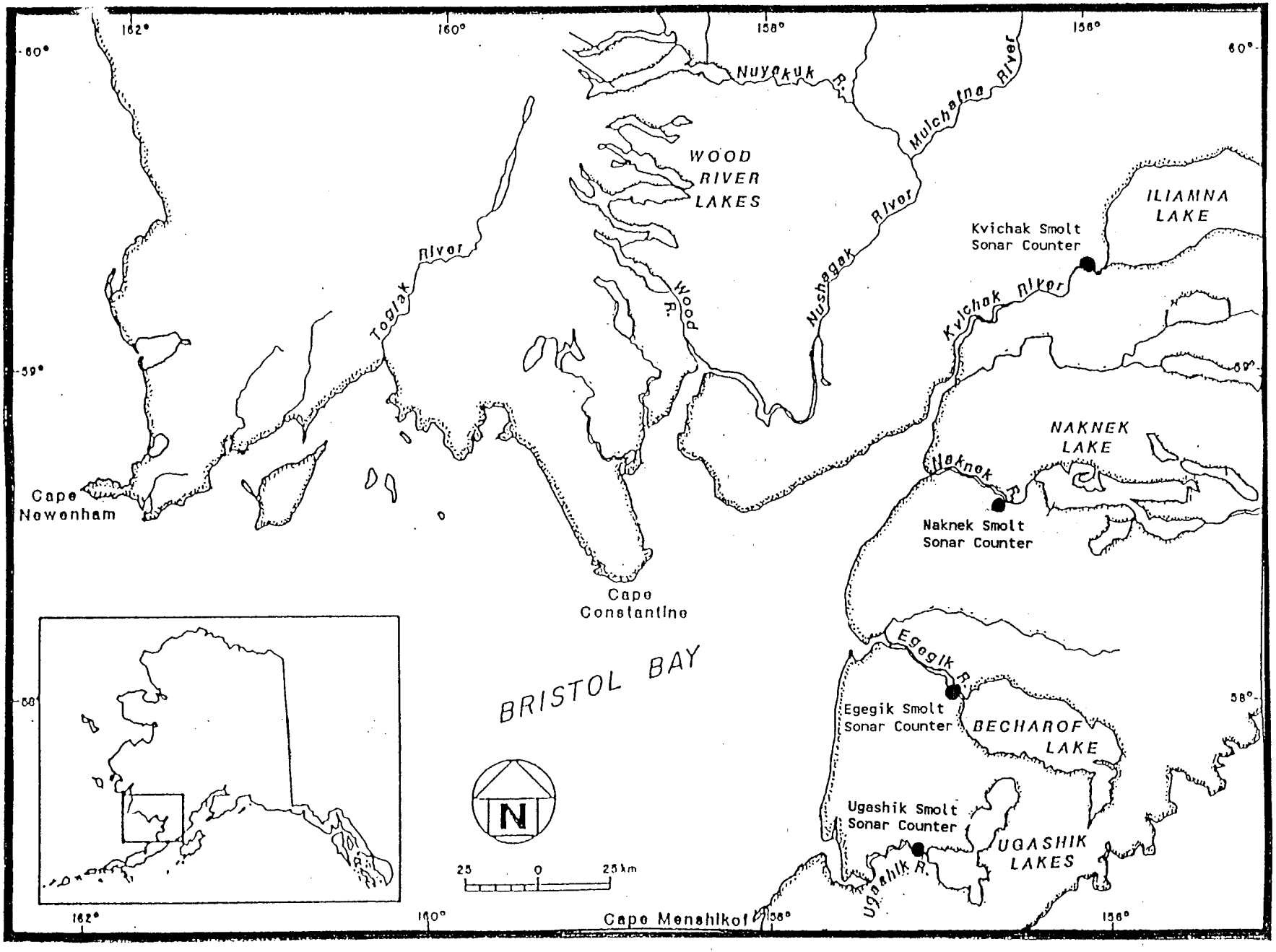

Figure 1. Bristol Bay Management Area with major rivers and locations of smolt counting projects, 1994.

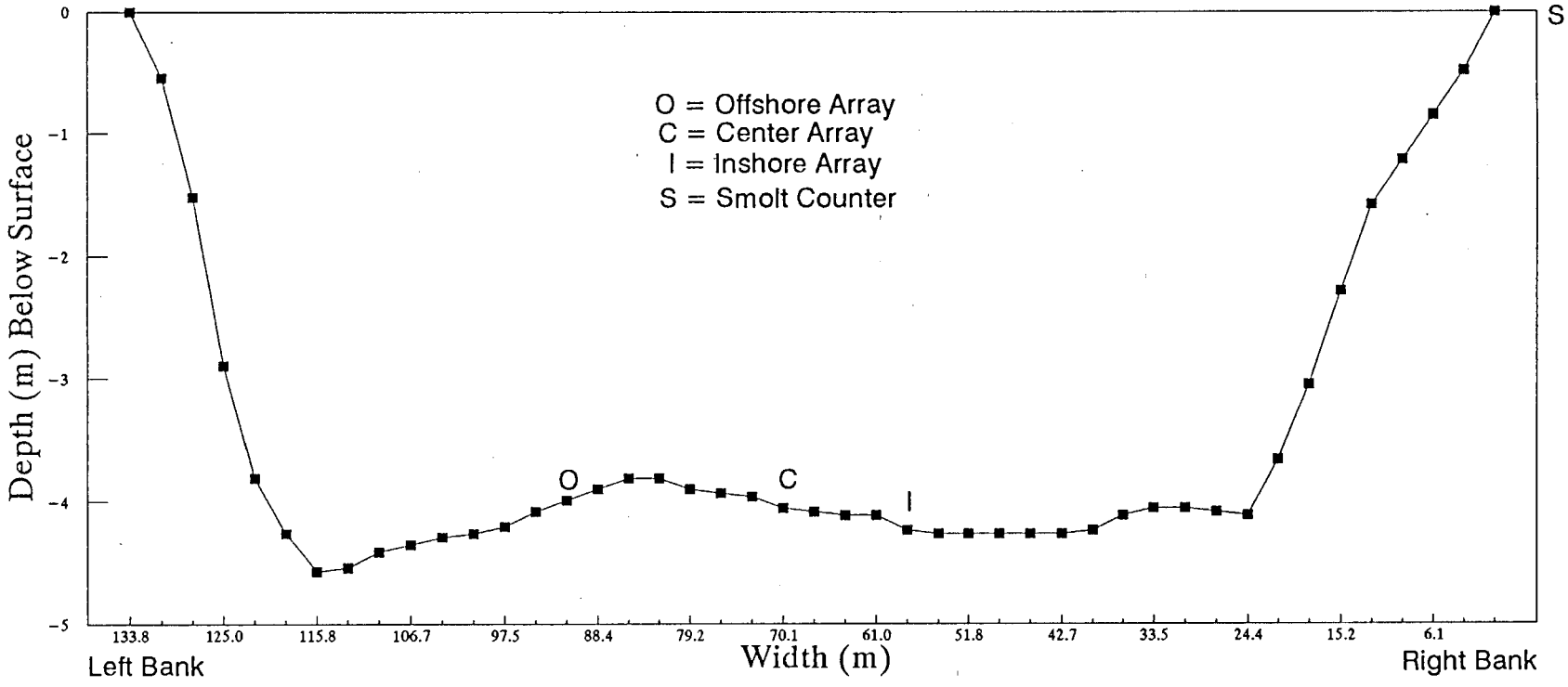

Figure 2. River bottom profile and sonar array placement at Kvichak River smolt site, 1994.

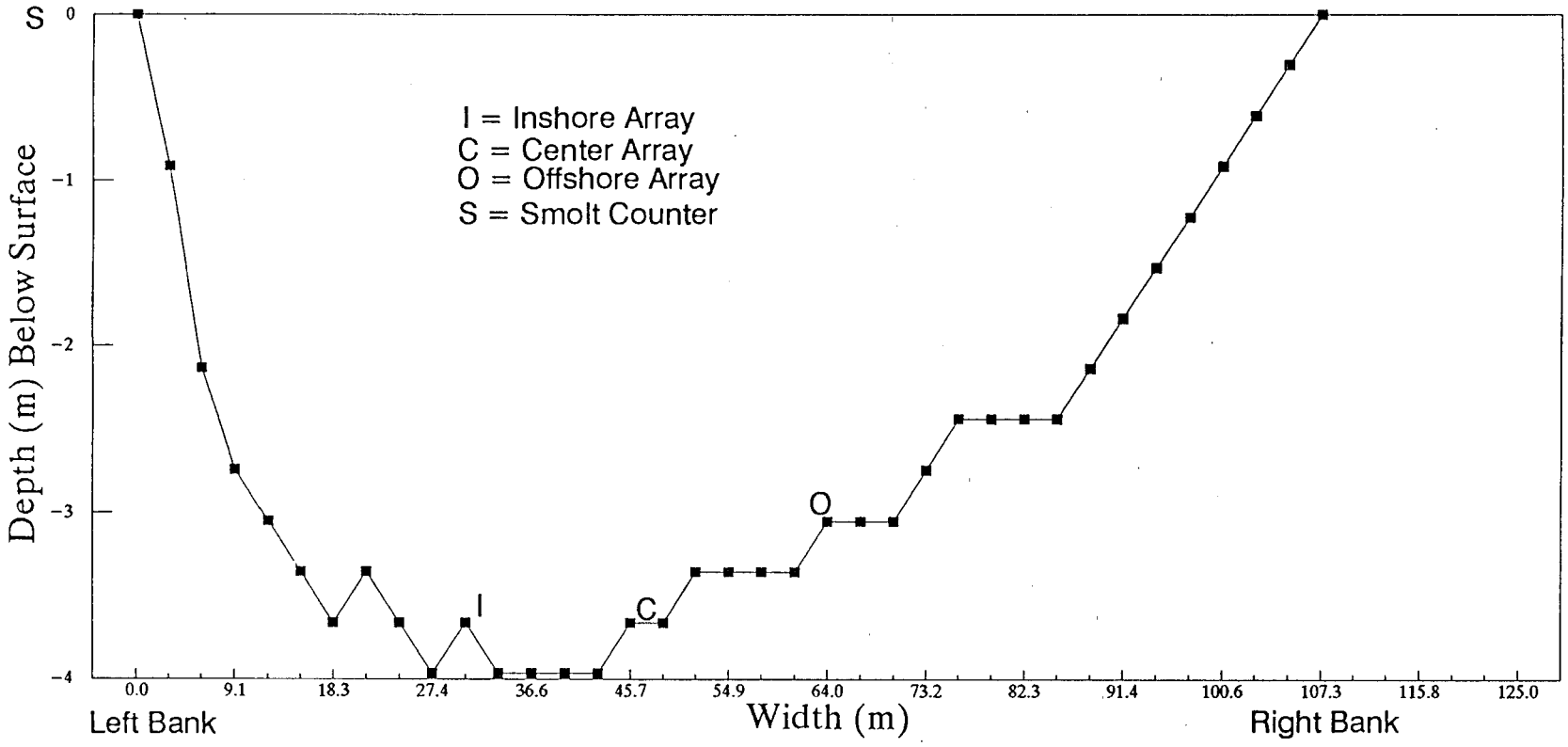

Figure 3. River bottom profile and sonar array placement at Naknek River smolt site, 1994.

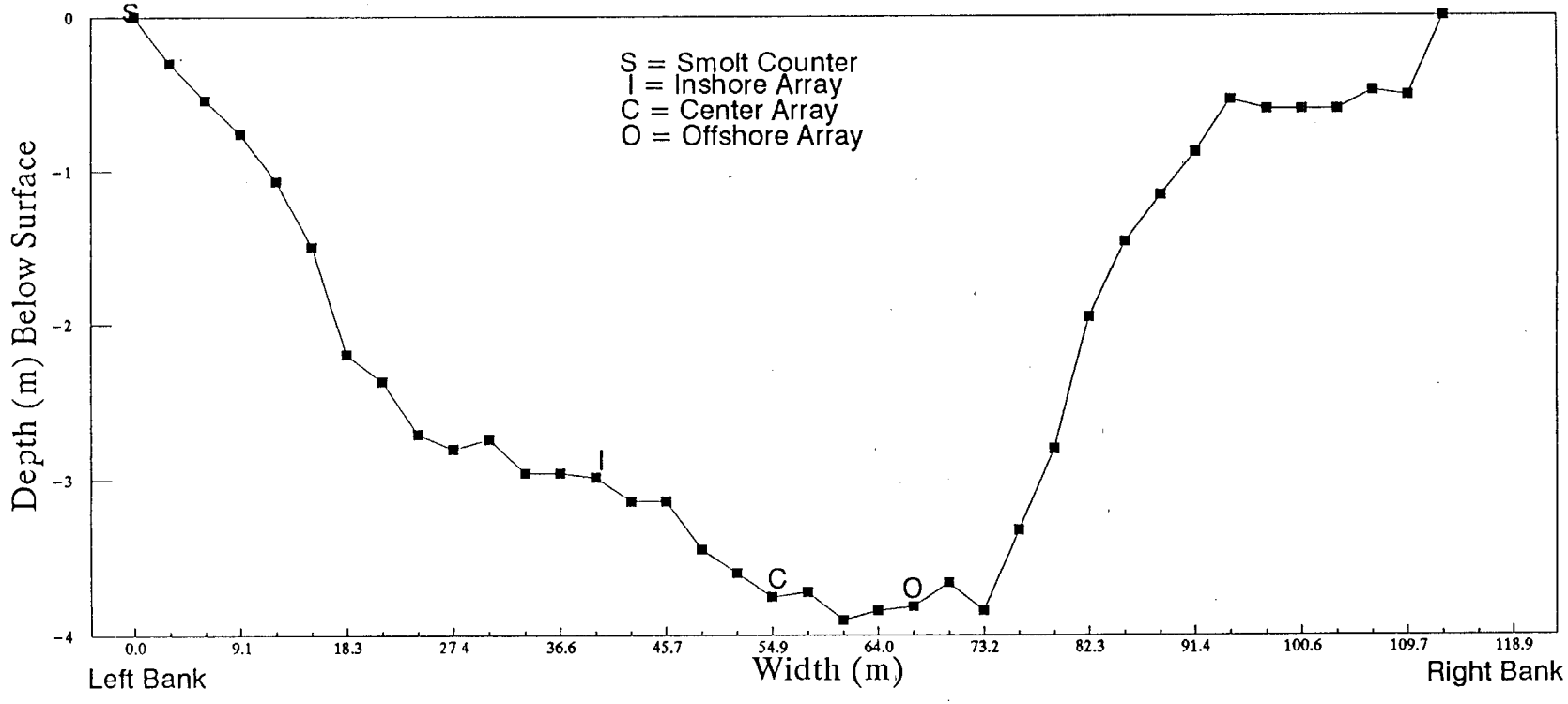

Figure 4. River bottom profile and sonar array placement at Egegik River smolt site, 1994.

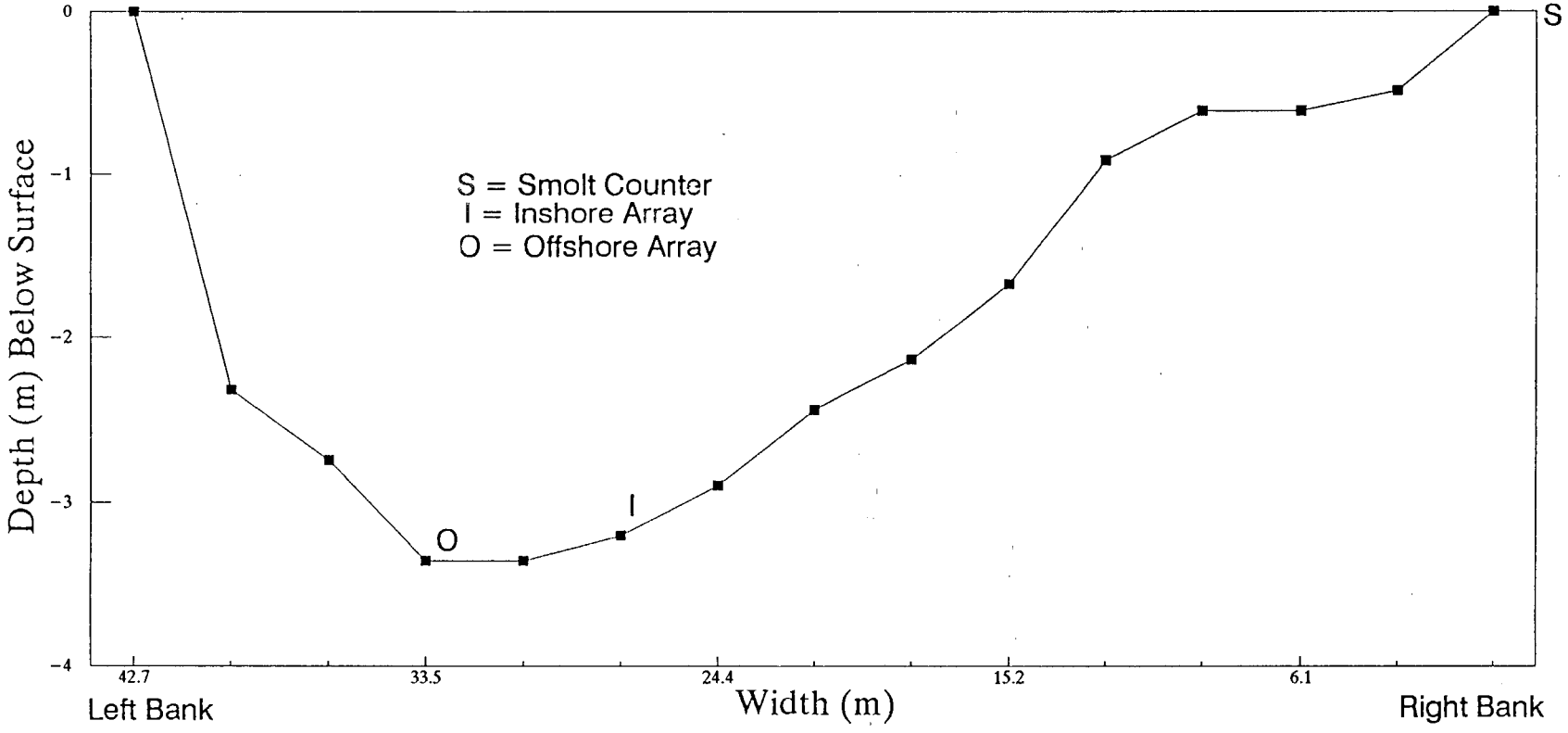

Figure 5. River bottom profile and sonar array placement at Ugashik River smolt site, 1994.

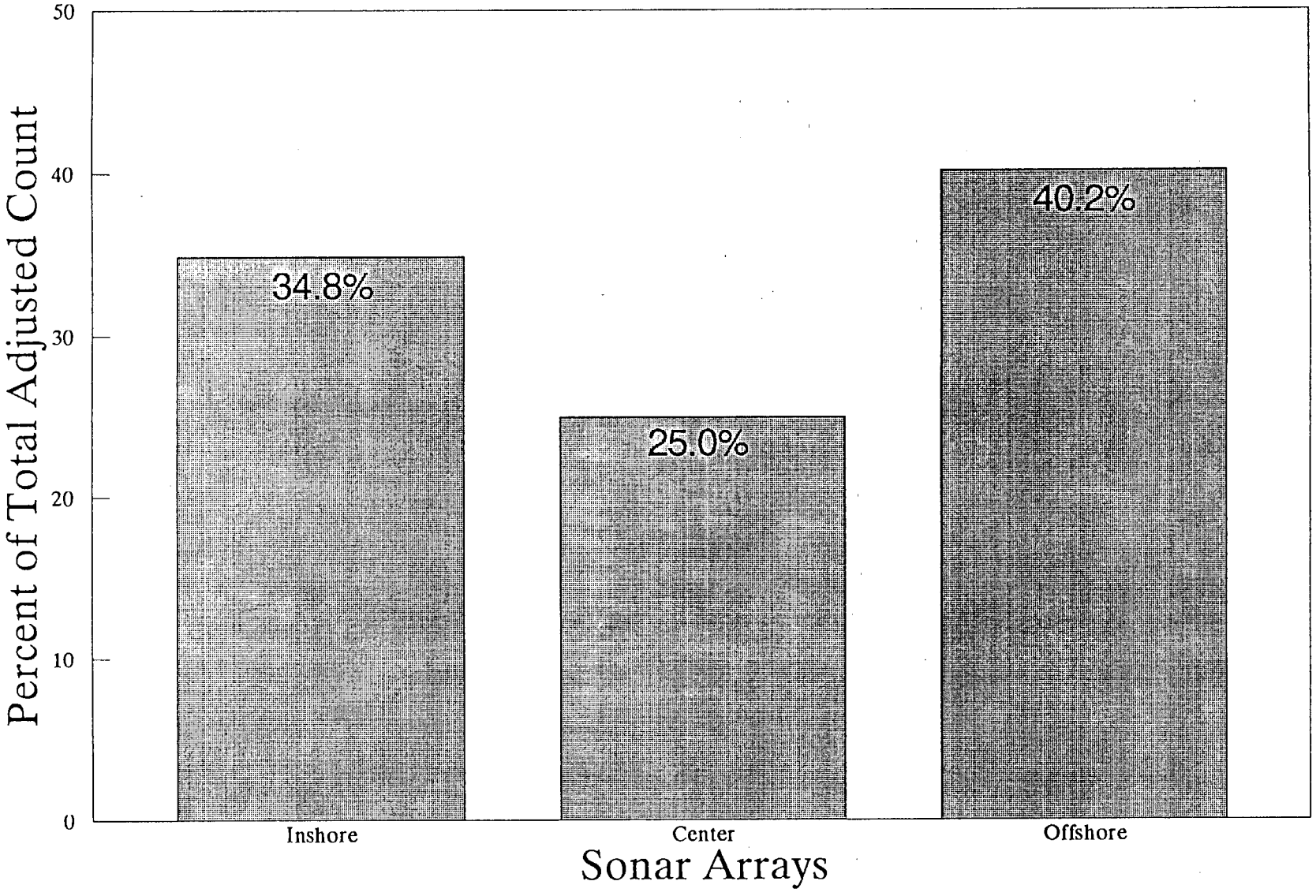

Figure 6. Lateral distribution of Kvichak River smolt sonar counts, 1994.

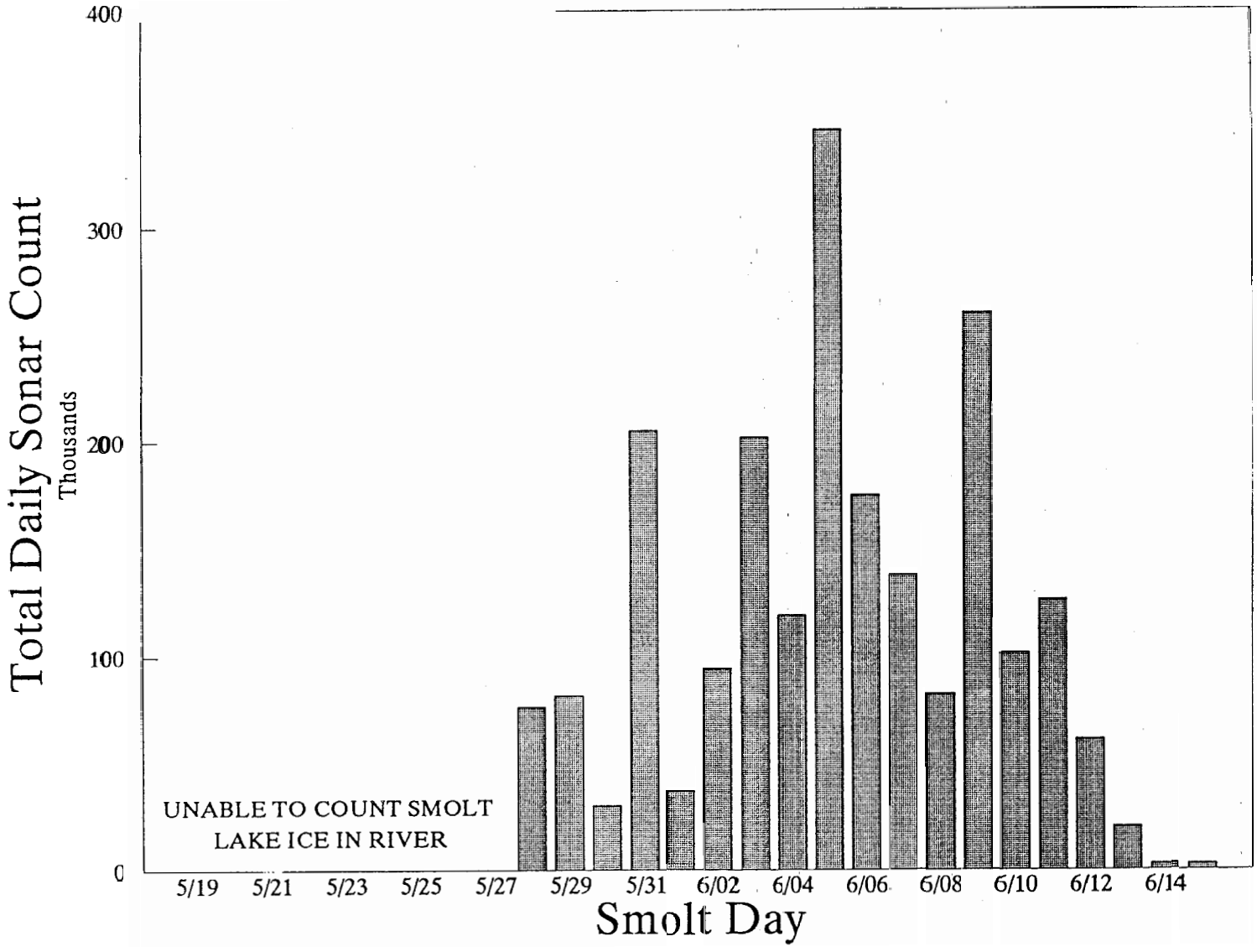

Figure 7. Total daily sonar counts at Kvichak River smolt project, May 28 to June 15, 1994.

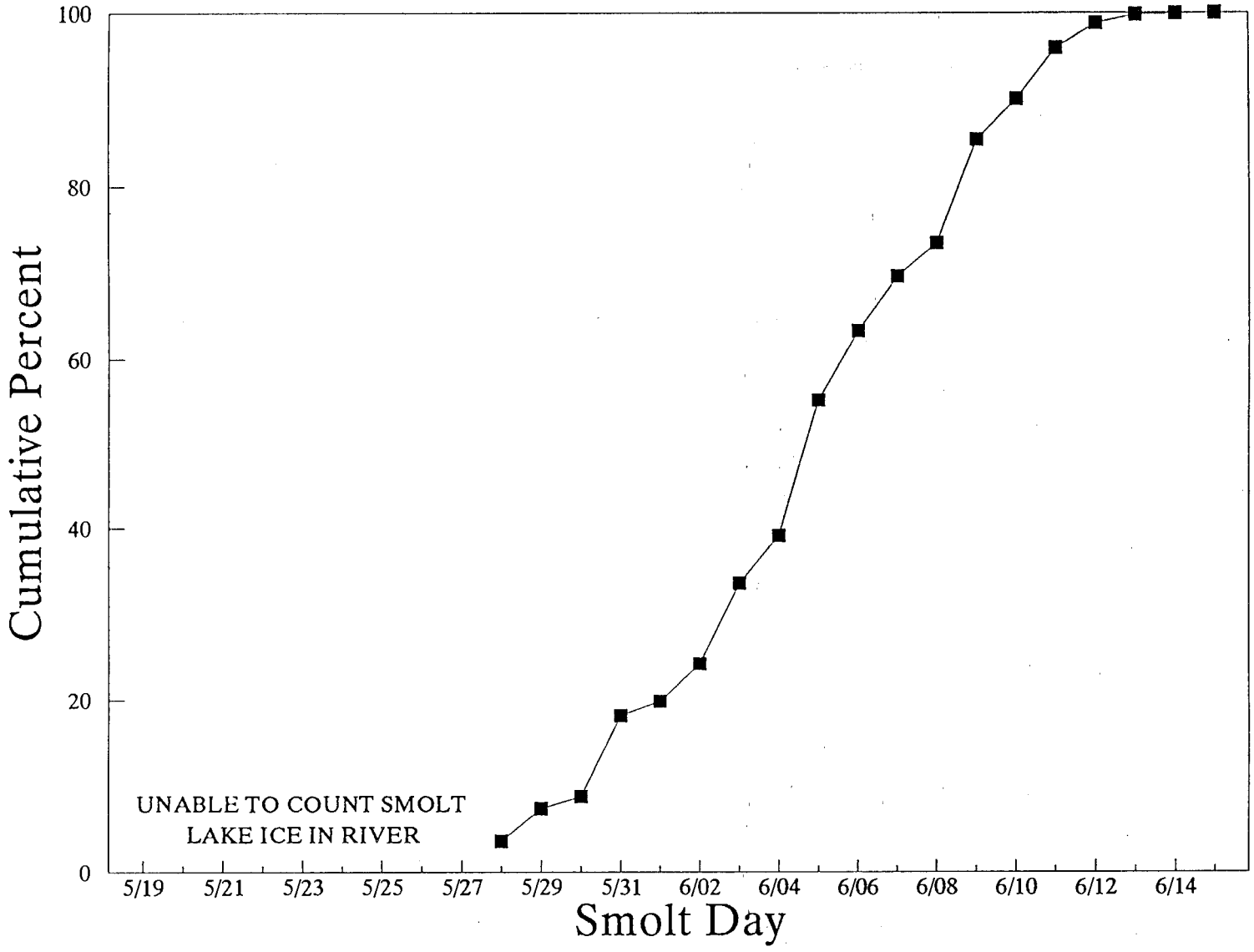

Figure 8. Kvichak River smolt sonar count, cumulative percent by smolt day, May 28 to June 15, 1994.

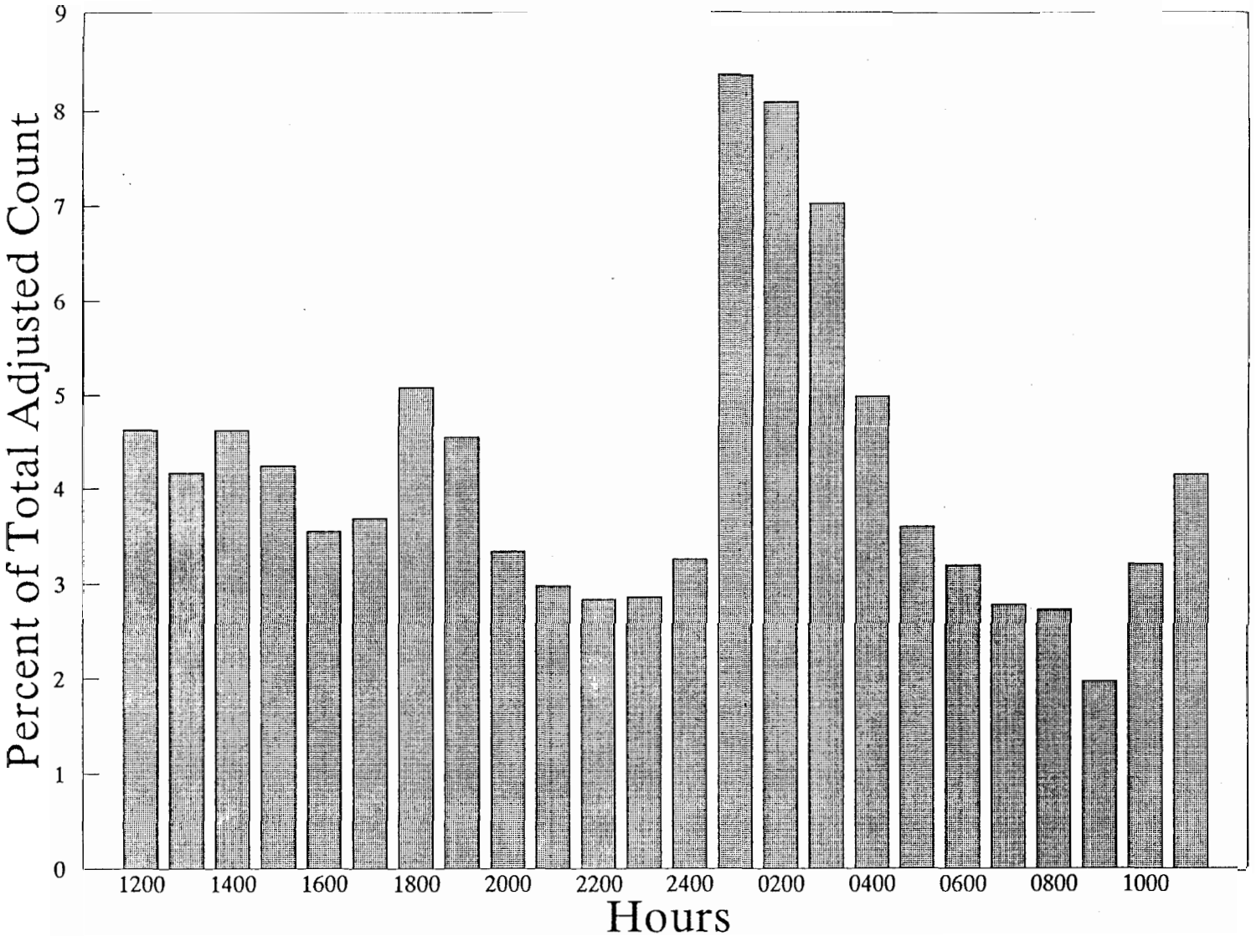

Figure 9. Percent of the total adjusted sonar count summarized by hour, Kvichak River smolt project, May 28 to June 15, 1994.

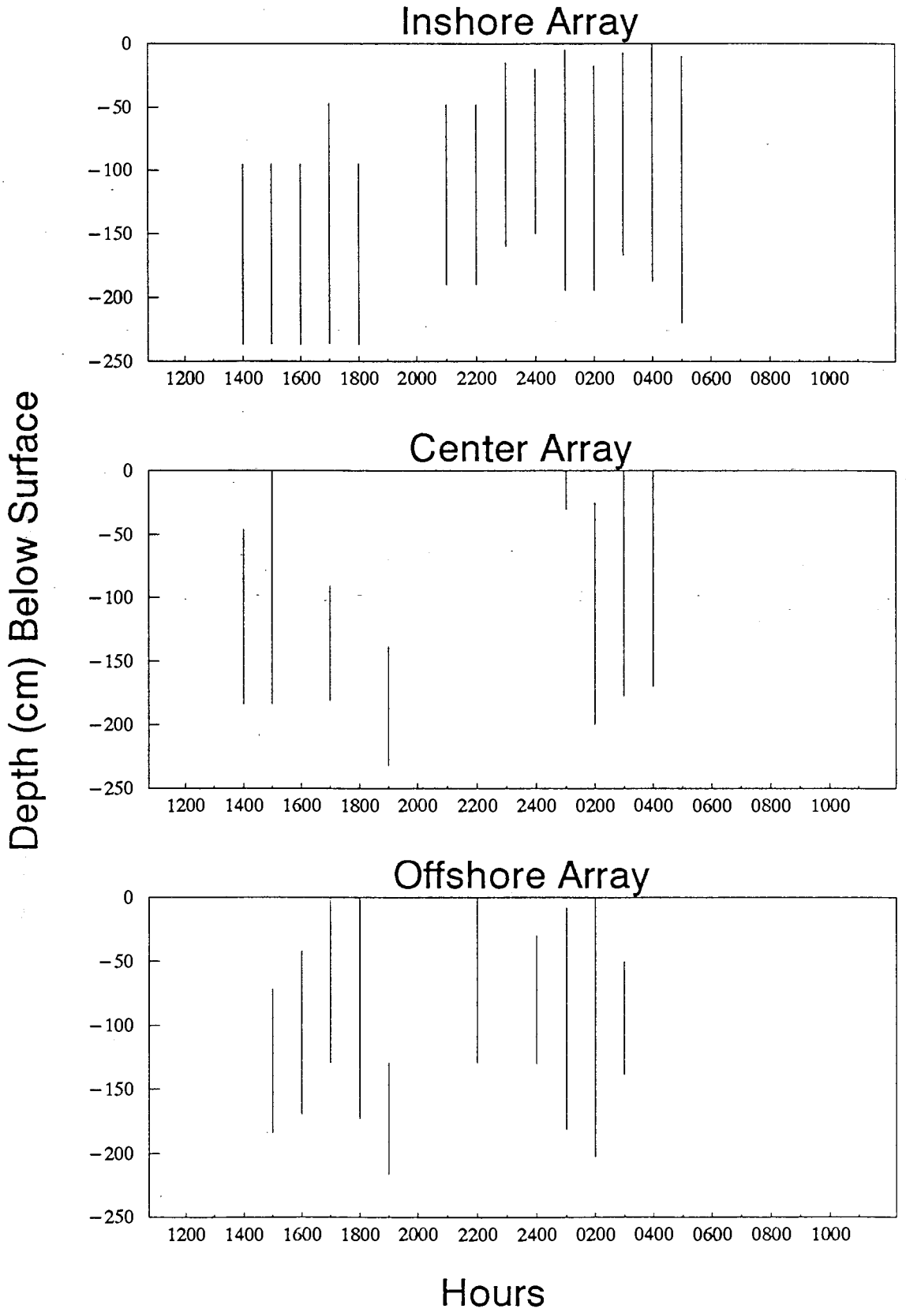

Figure 10. Depth of smolt passage data summarized by hour, Kvichak River, May 28 to June 10, 1994.

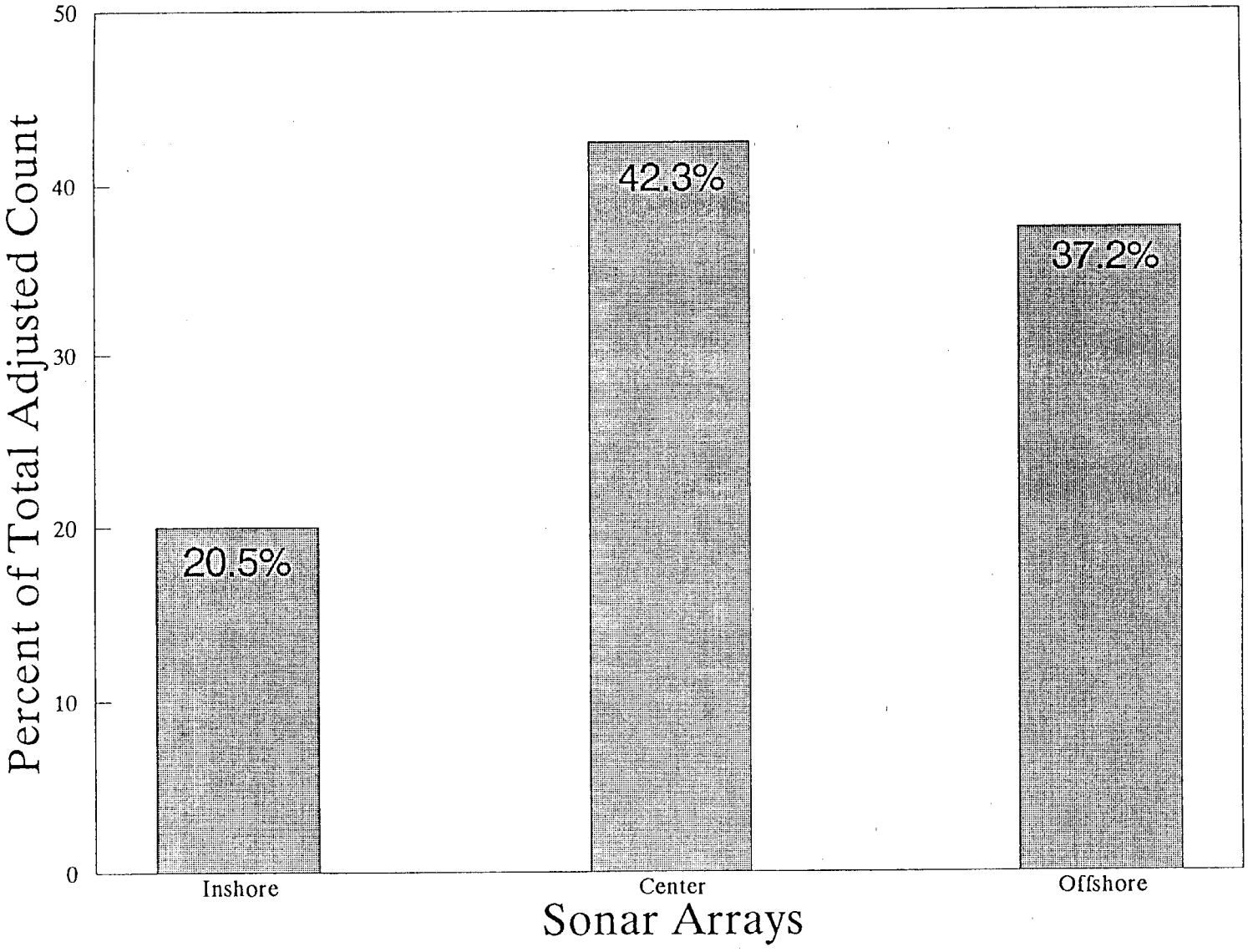

Figure 11. Lateral distribution of Naknek River smolt sonar counts, 1994.

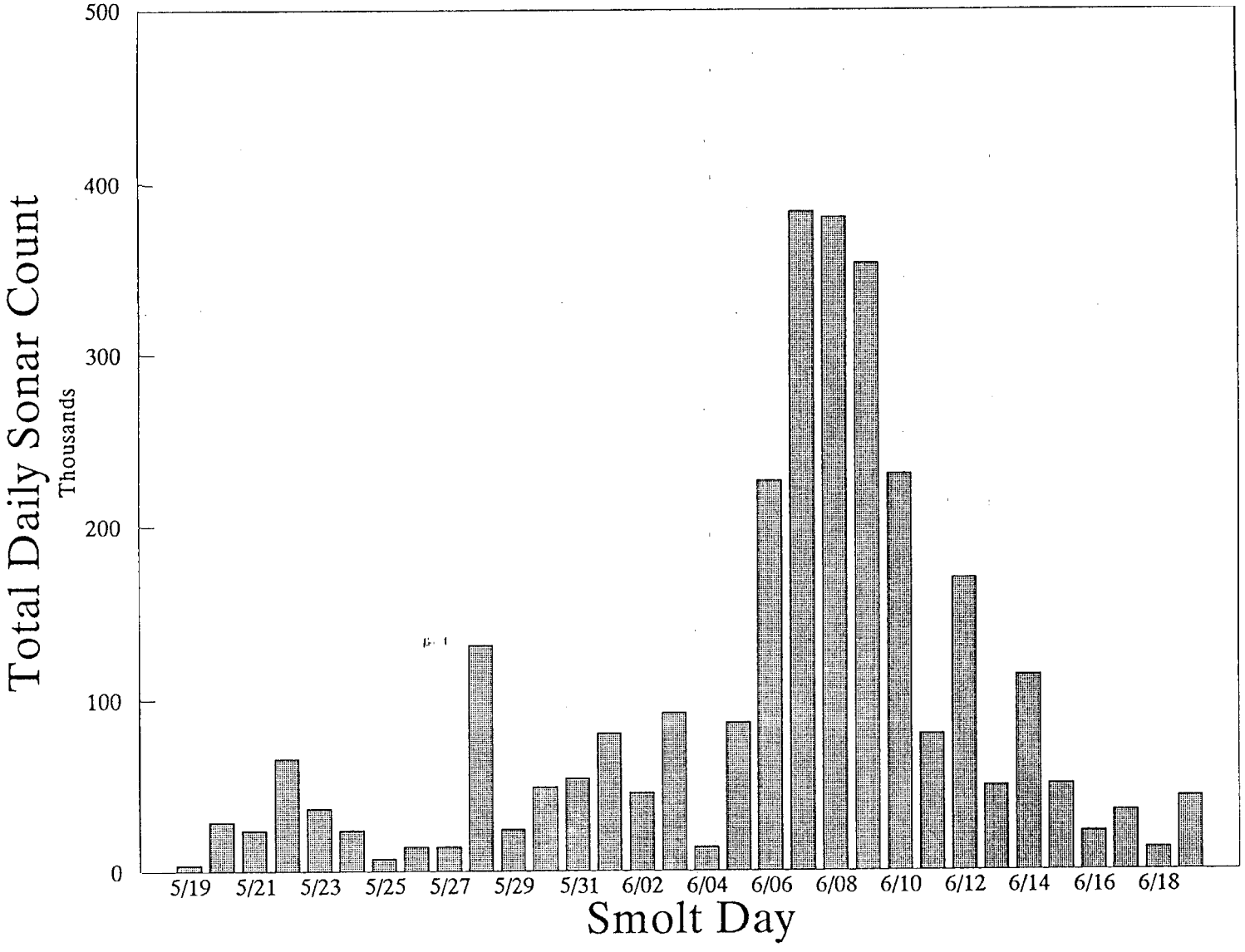

Figure 12. Total daily sonar counts at Naknek River smolt project, May 19 to June 19, 1994.

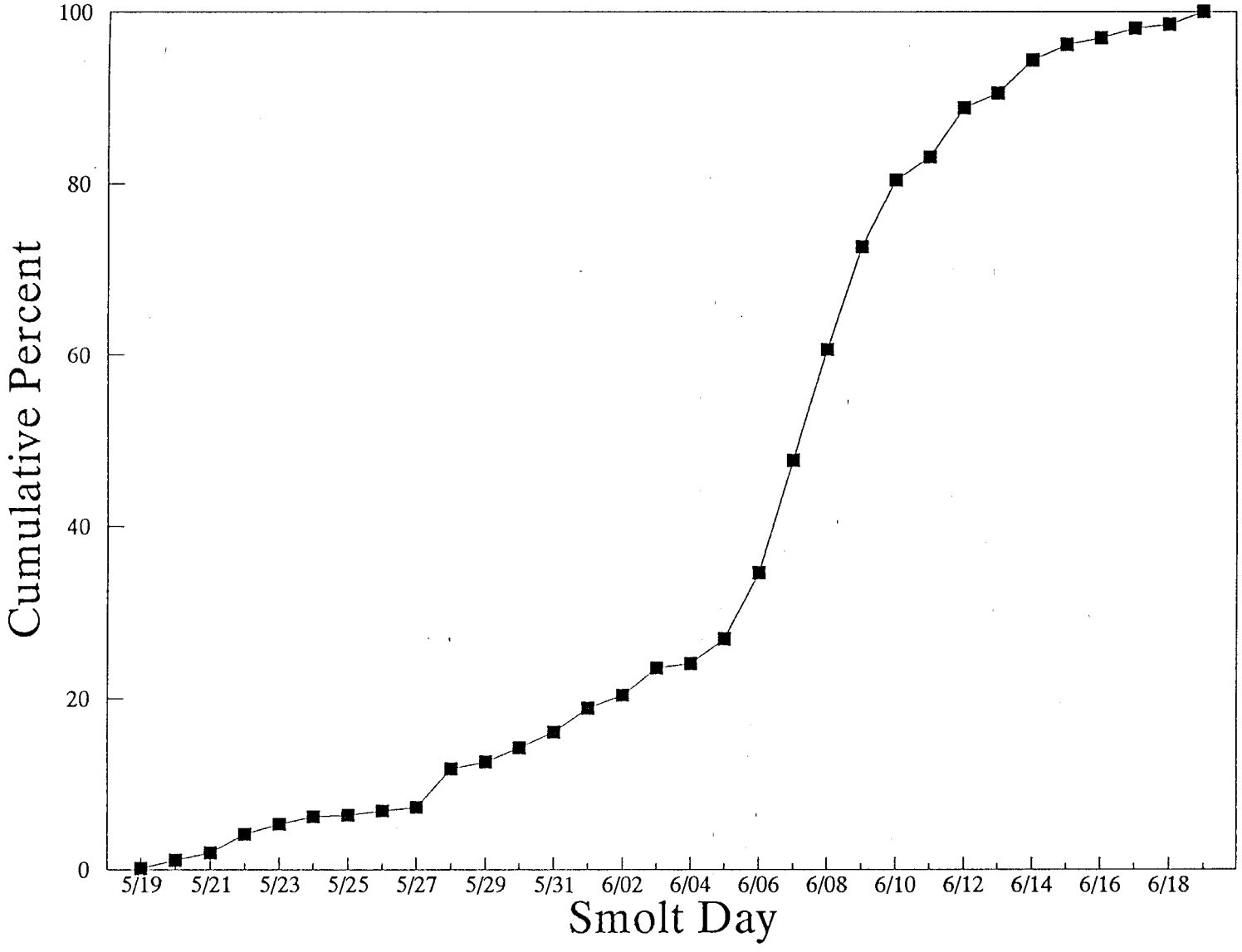

Figure 13. Naknek River smolt sonar count, cumulative percent by smolt day, May 19 to June 19, 1994.

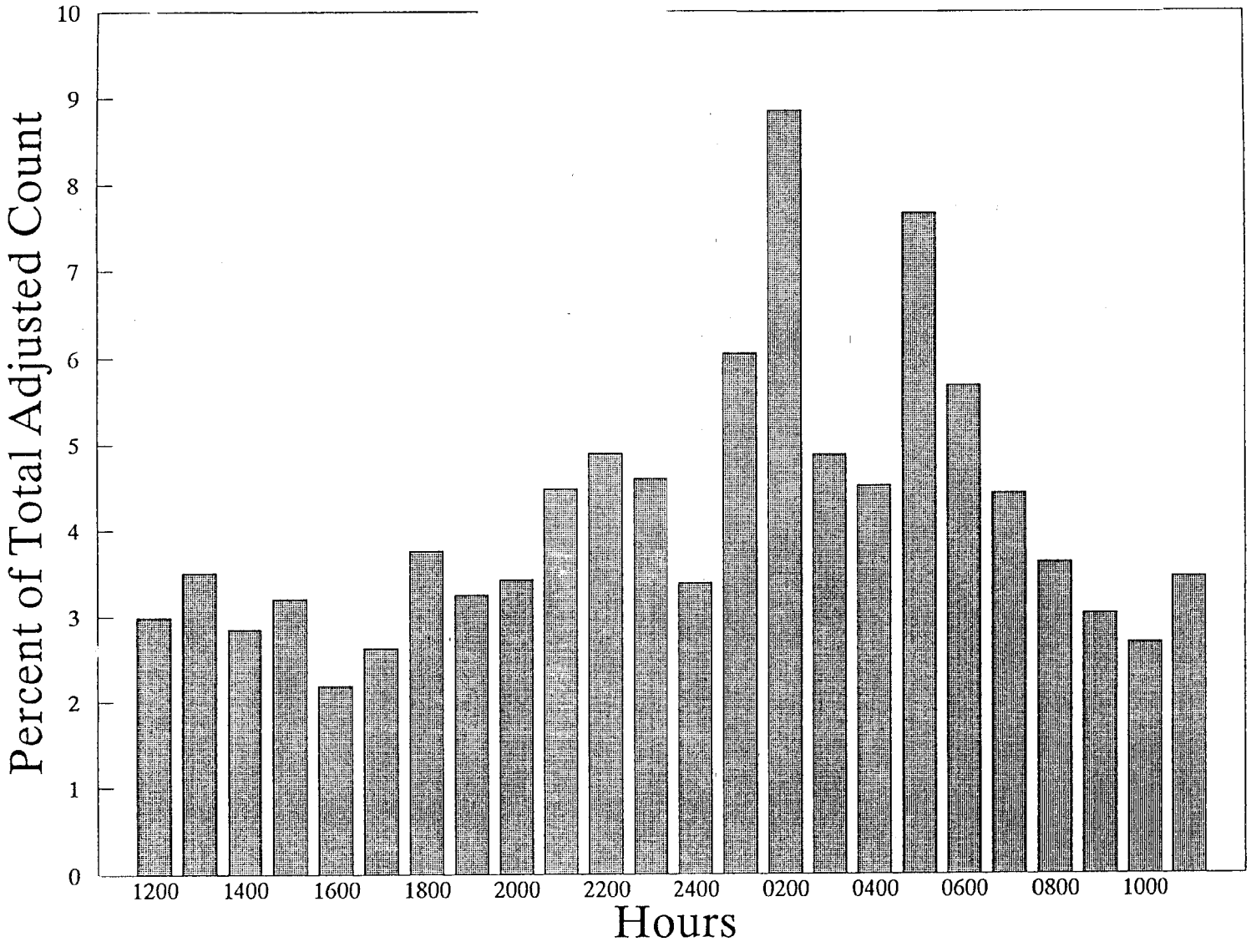

Figure 14. Percent of the total adjusted sonar count summarized by hour, Naknek River smolt project, May 19 to June 19, 1994.

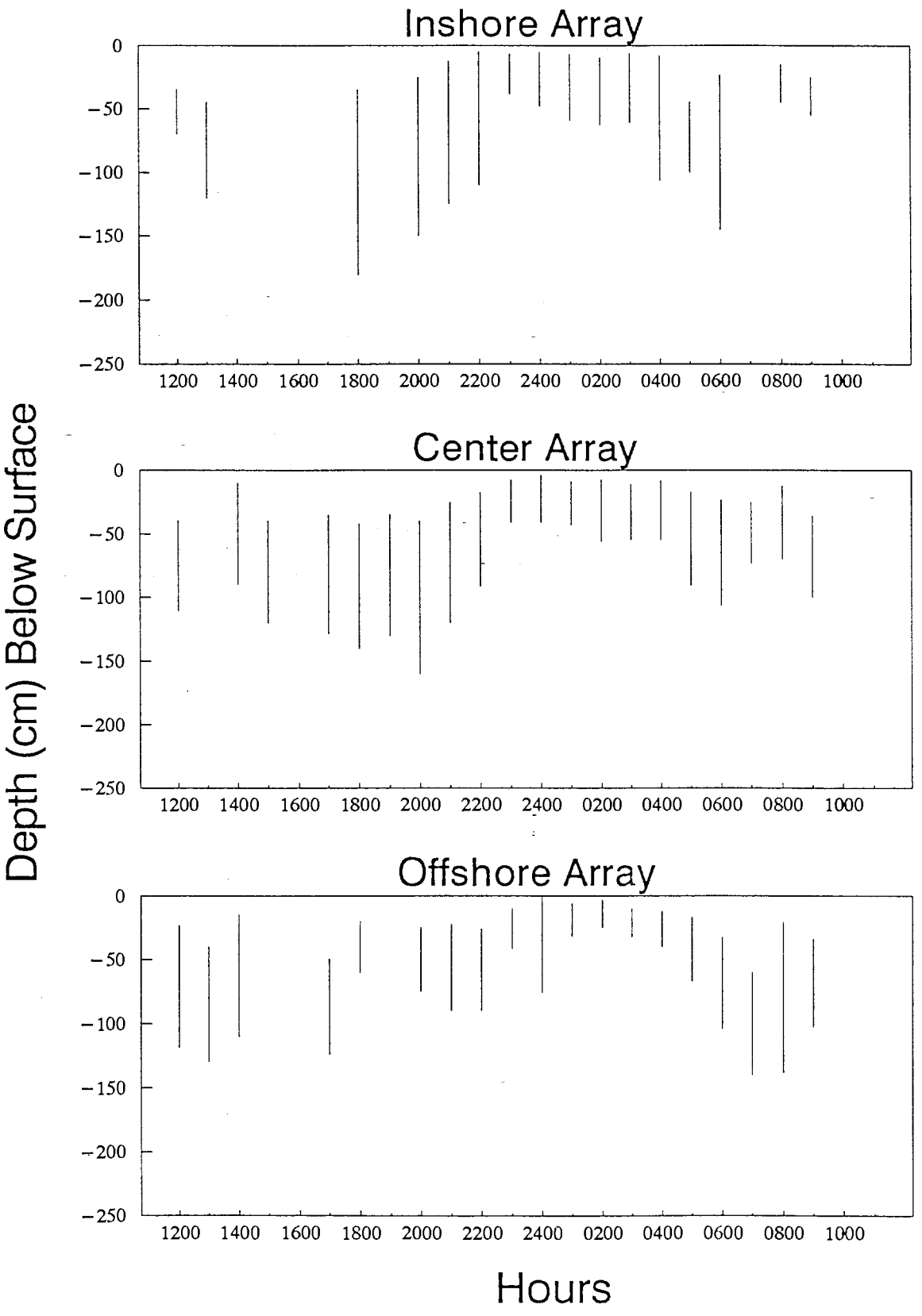

Figure 15. Depth of smolt passage data summarized by hour, Naknek River, May 20 to June 19, 1994.

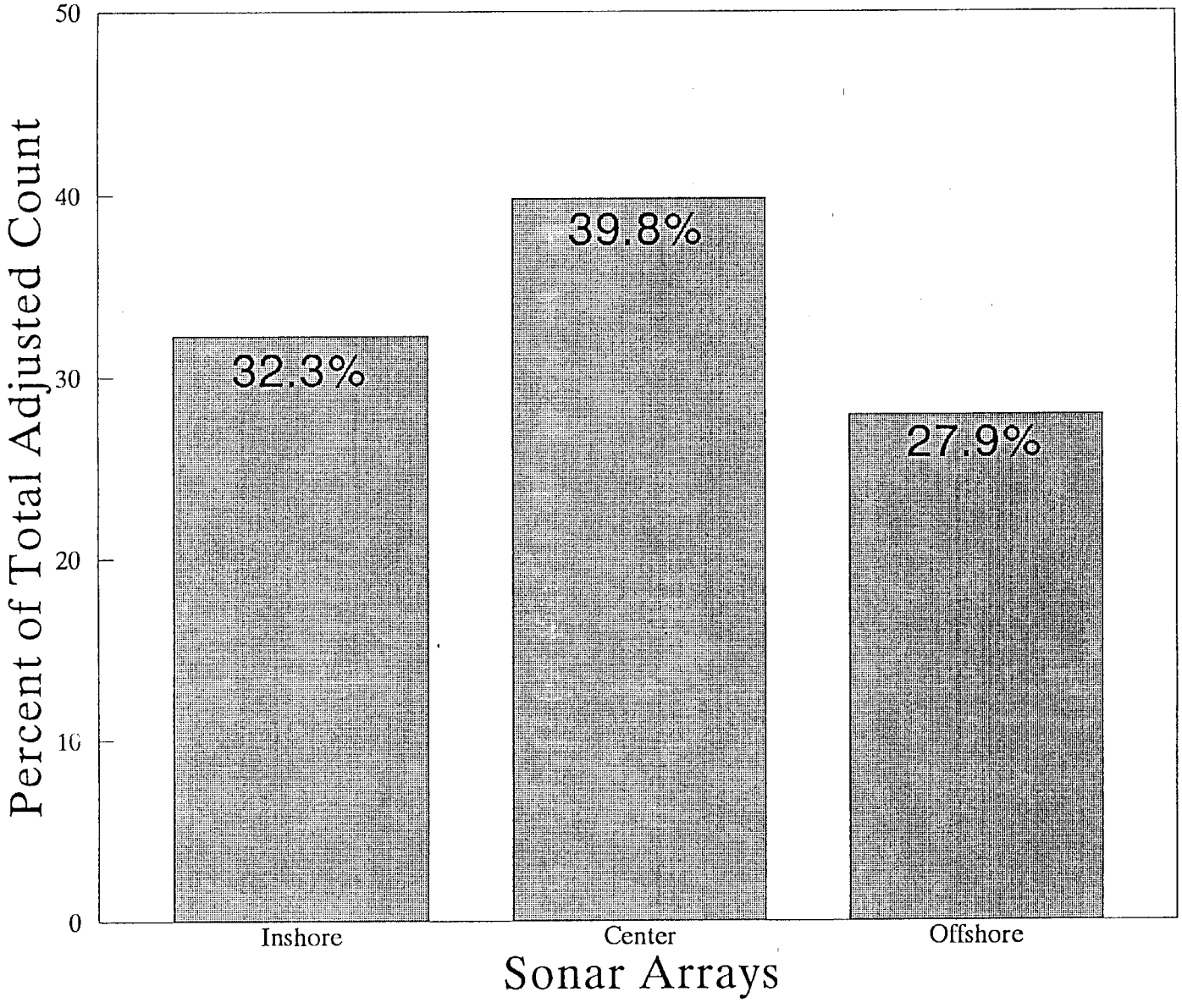

Figure 16. Lateral distribution of Egegik River smolt sonar counts, 1994.

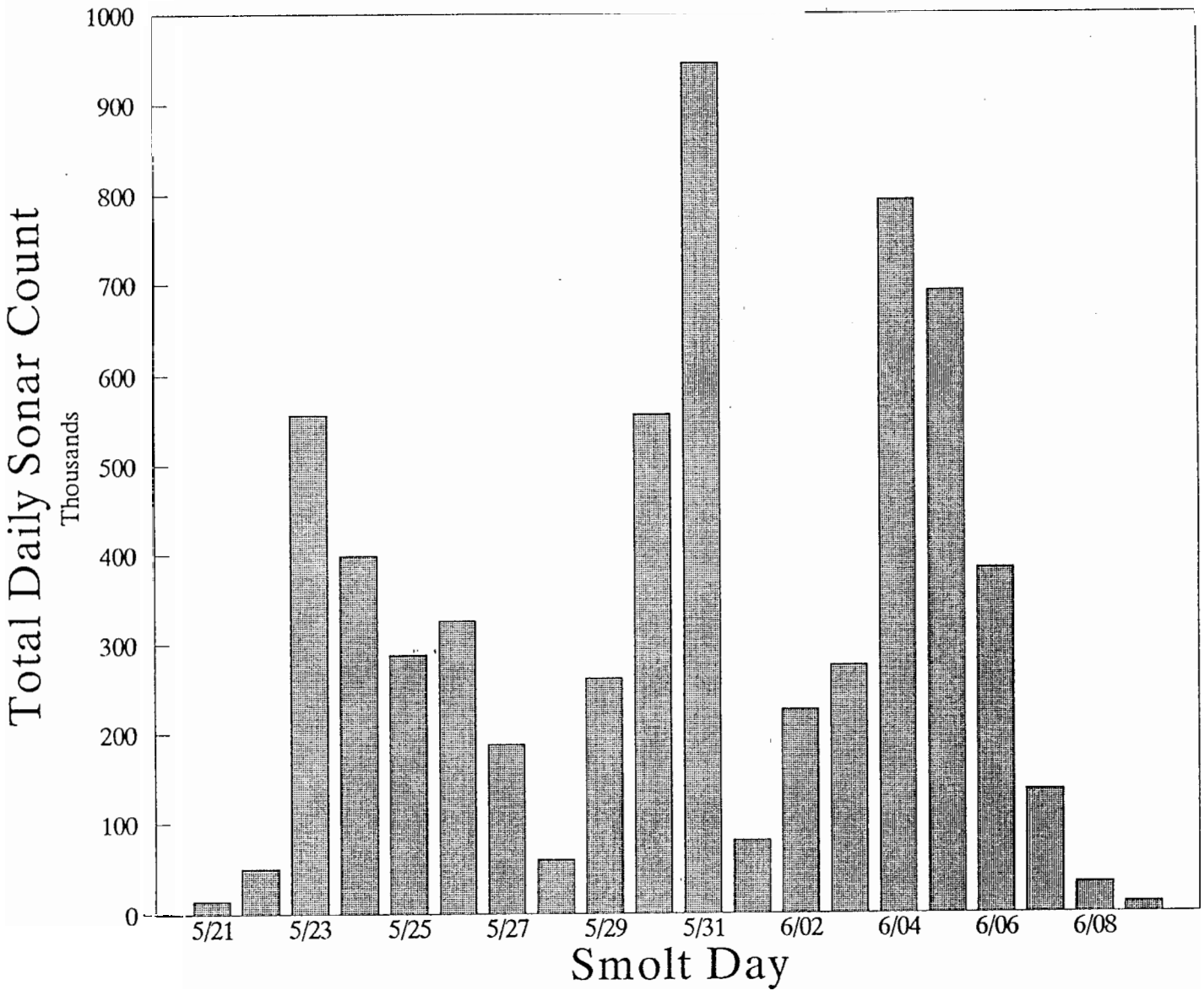

Figure 17. Total daily sonar counts at Egegik River smolt project, May 21 to June 9, 1994.

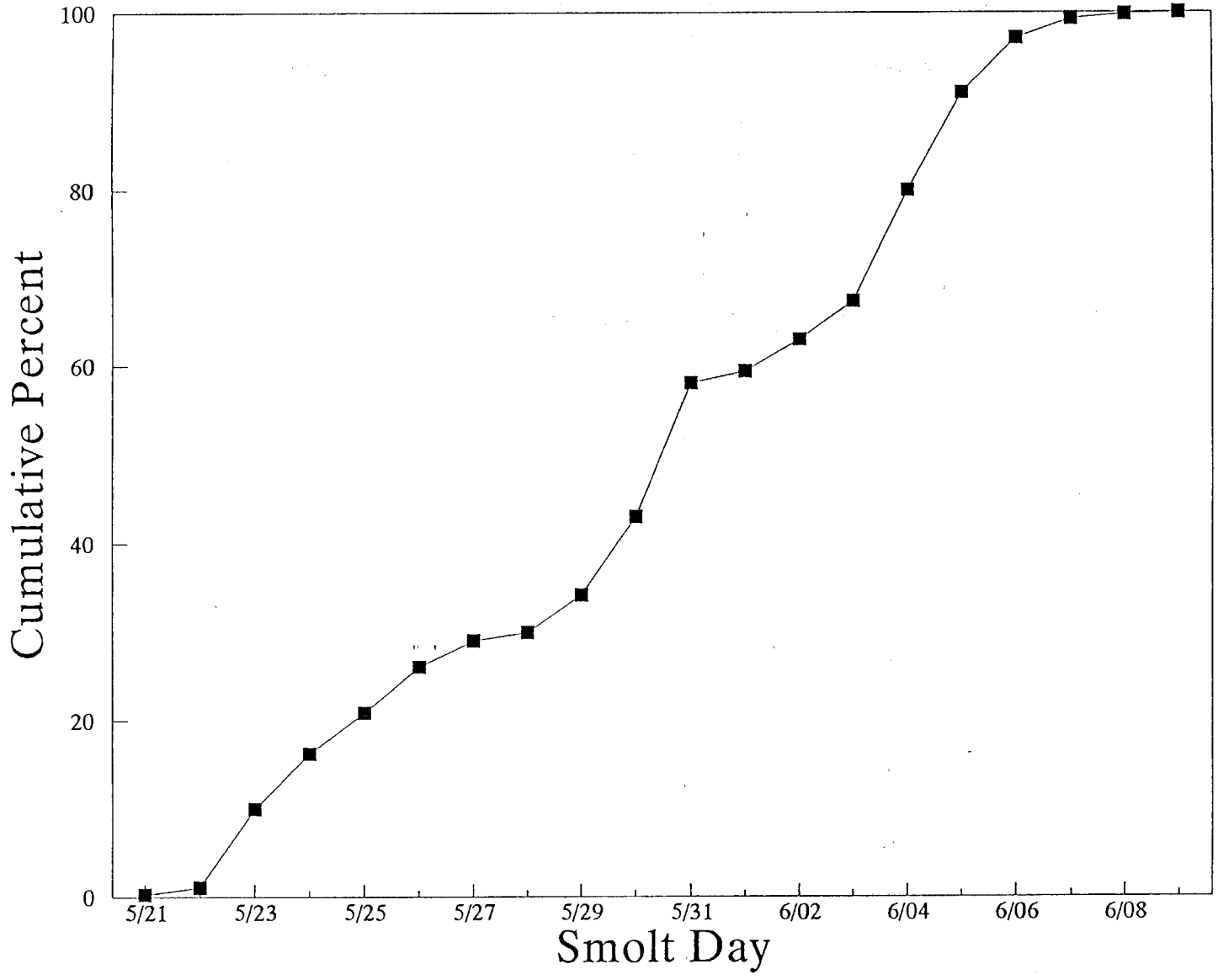

Figure 18. Egegik River smolt sonar count, cumulative percent by smolt day, May 21 to June 9, 1994.

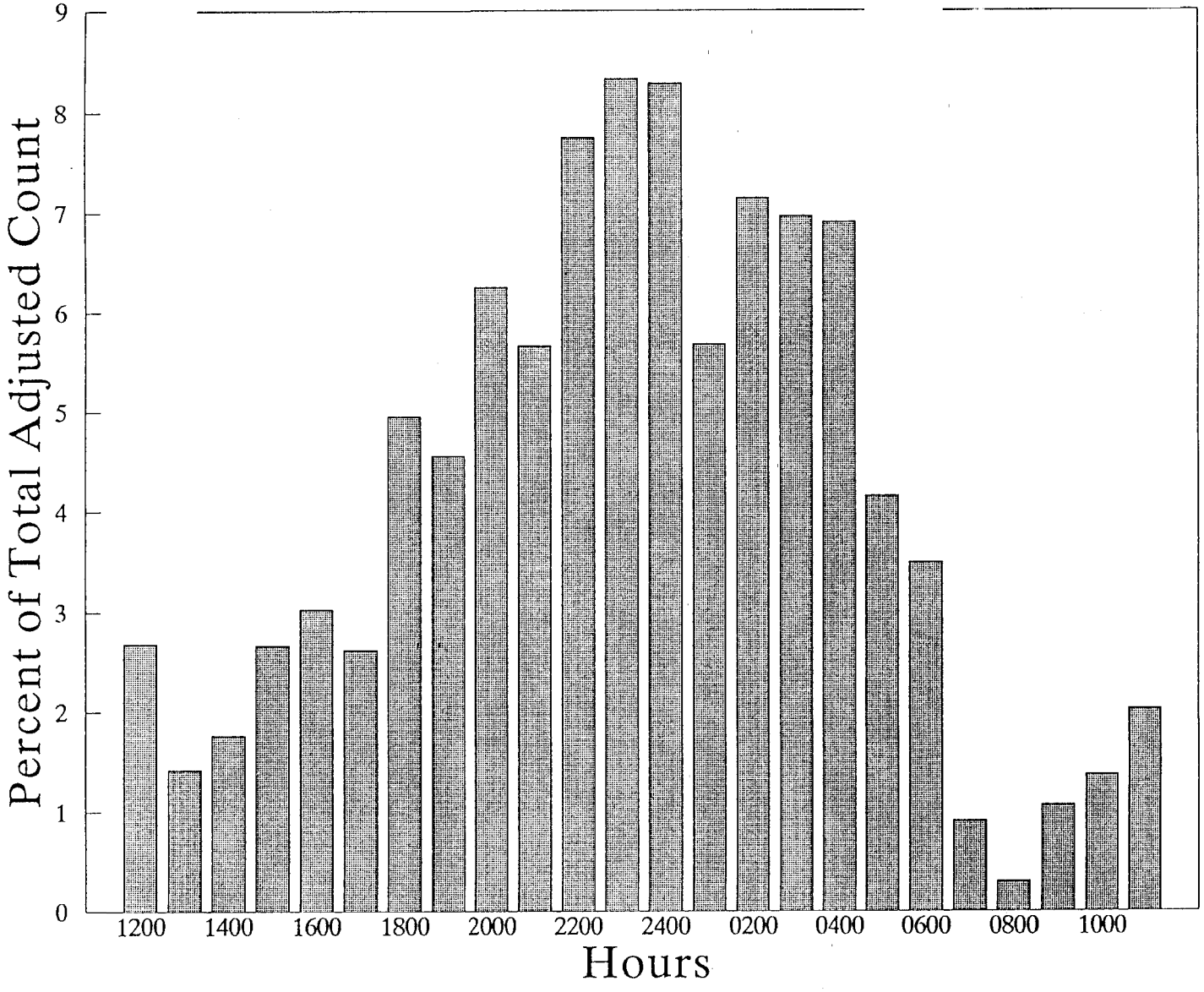

Figure 19. Percent of the total adjusted sonar count summarized by hour, Egegik River smolt project, May 21 to June 9, 1994.

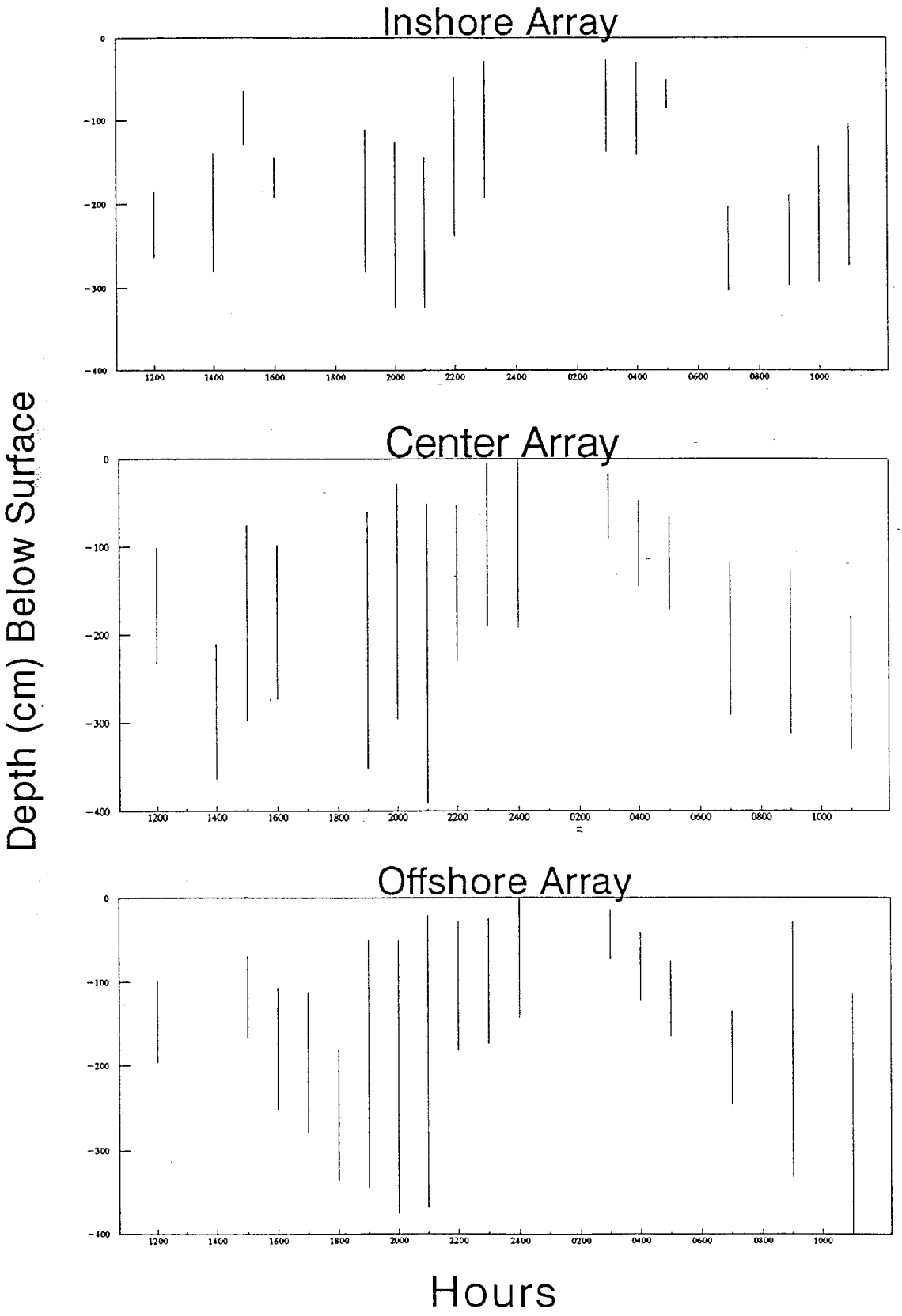

Figure 20. Depth of smolt passage data summarized by hour, Egegik River, May 23 to June 7, 1994.

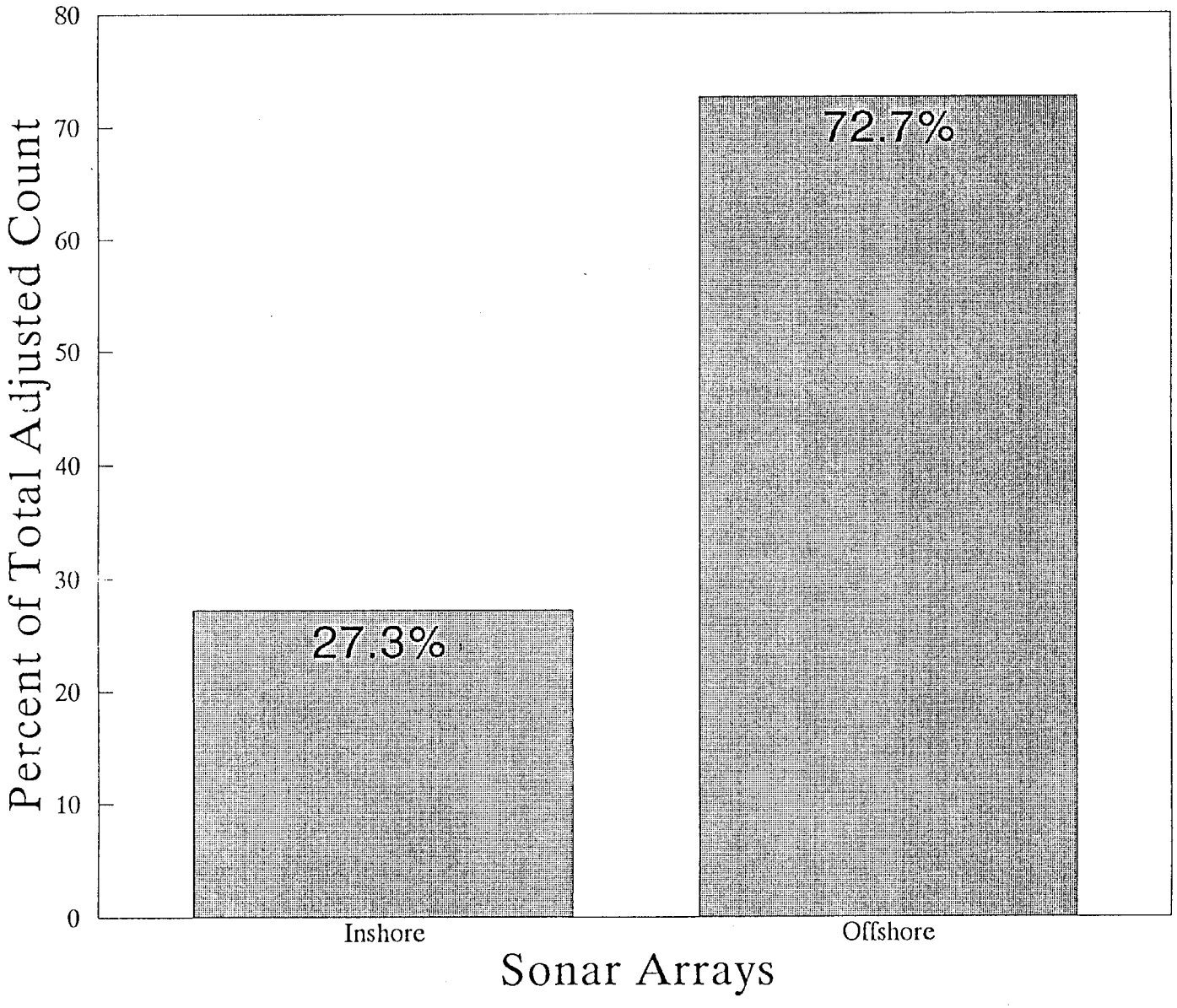

Figure 21. Lateral distribution of Ugashik River smolt sonar counts, 1994.

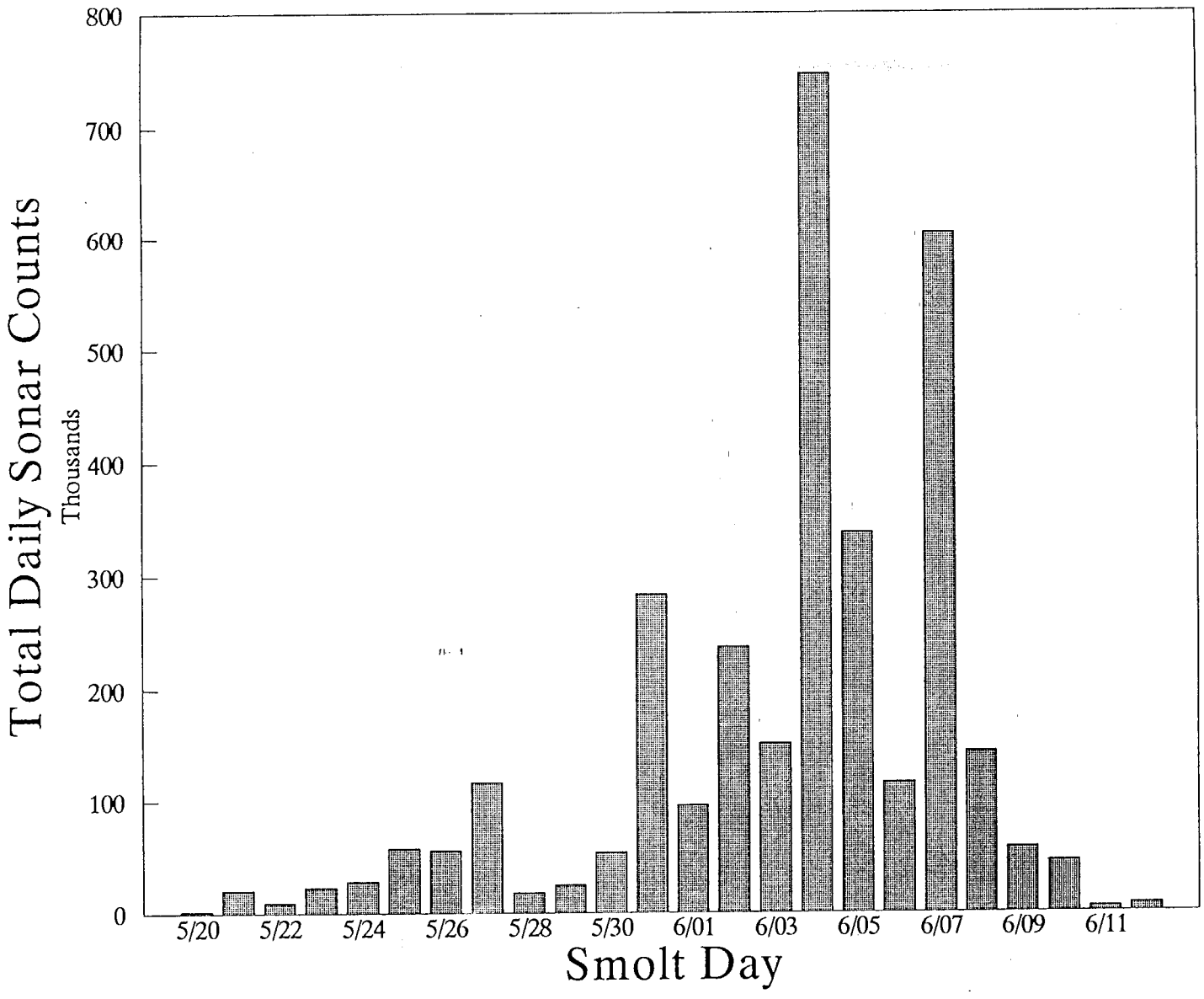

Figure 22. Total daily sonar counts at Ugashik River smolt project, May 20 to June 12, 1994.

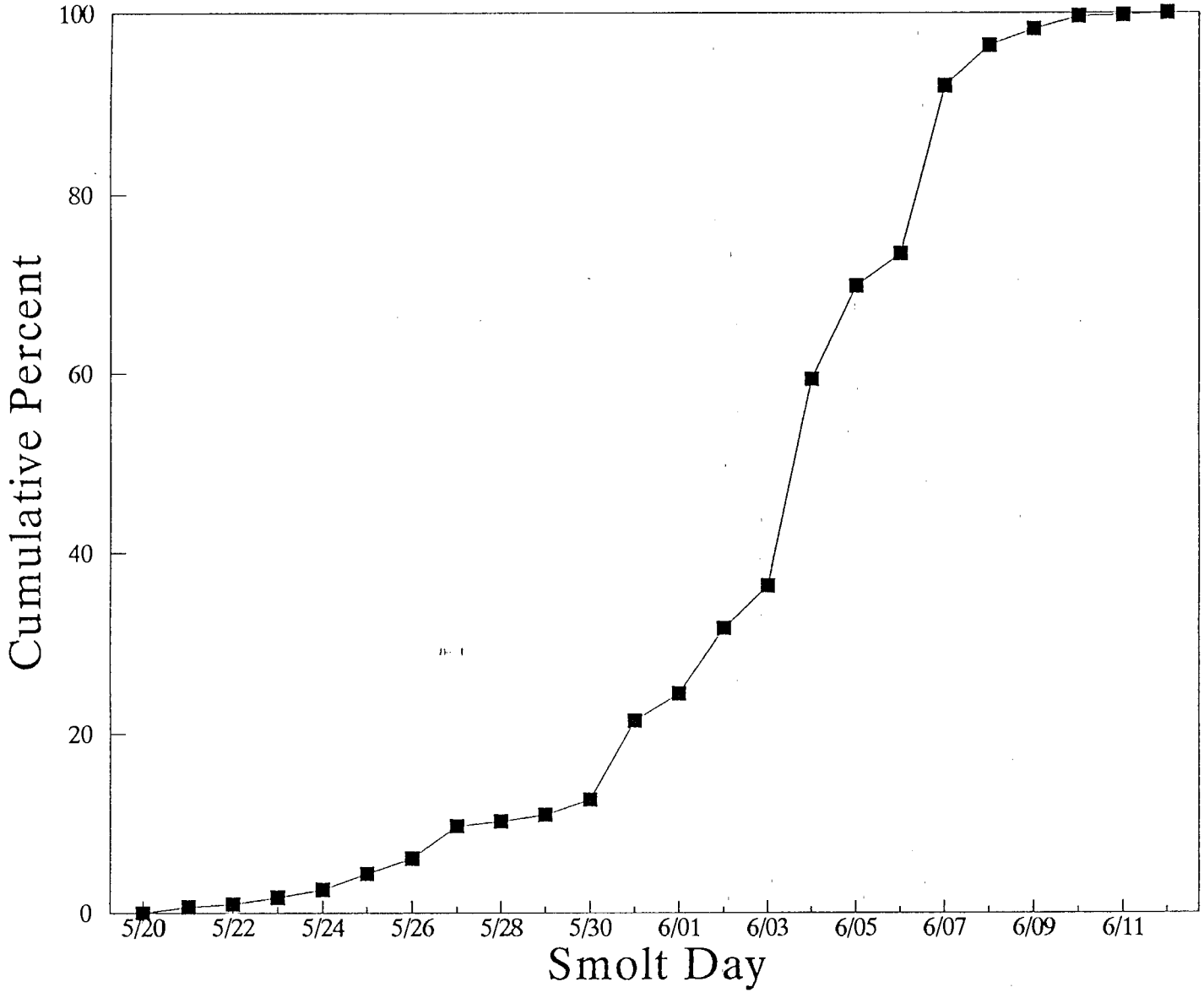

Figure 23. Ugashik River smolt sonar count, cumulative percent by smolt day, May 20 to June 12, 1994.

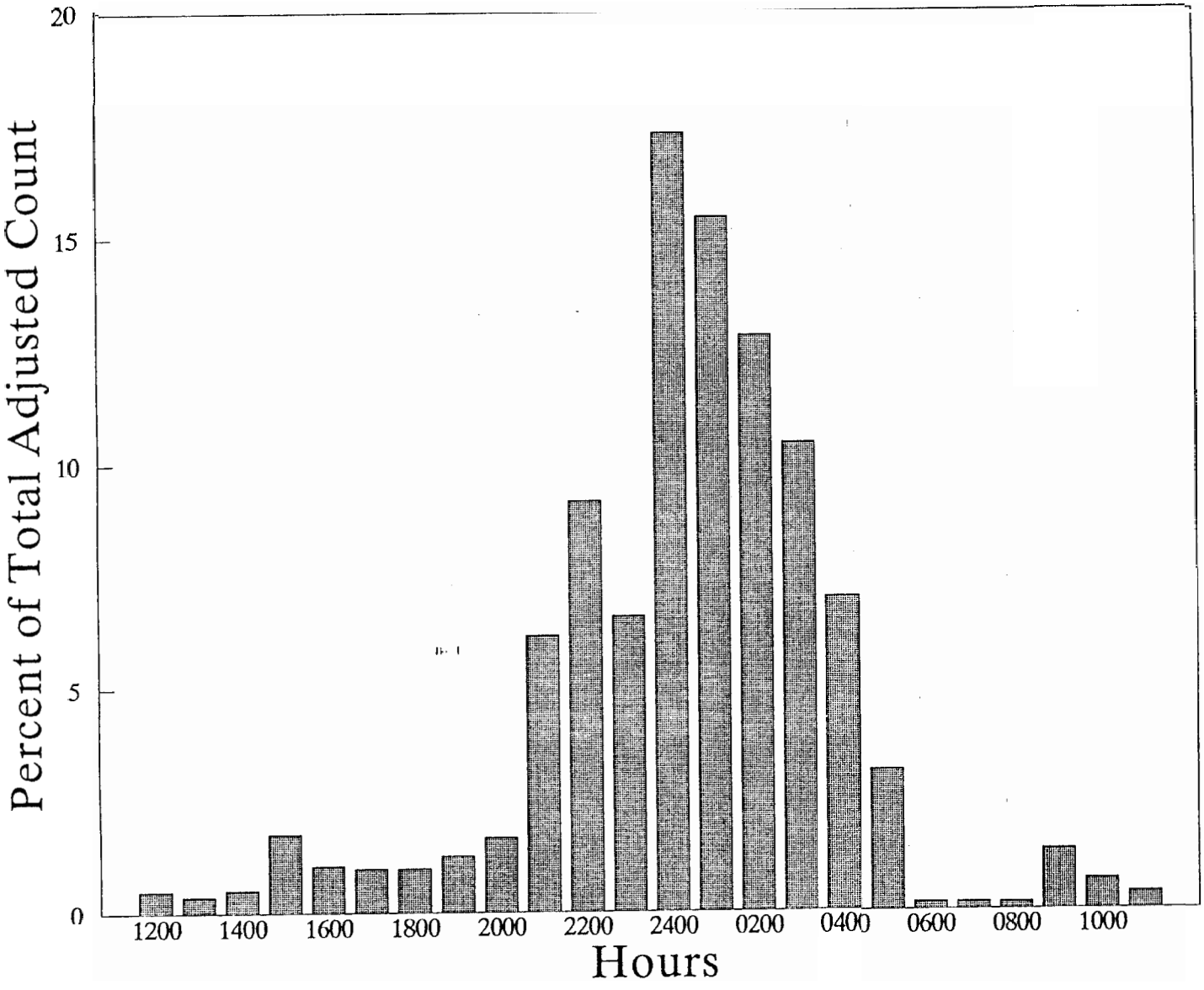

Figure 24. Percent of the total adjusted sonar count summarized by hour, Ugashik River smolt project, May 20 to June 12, 1994.

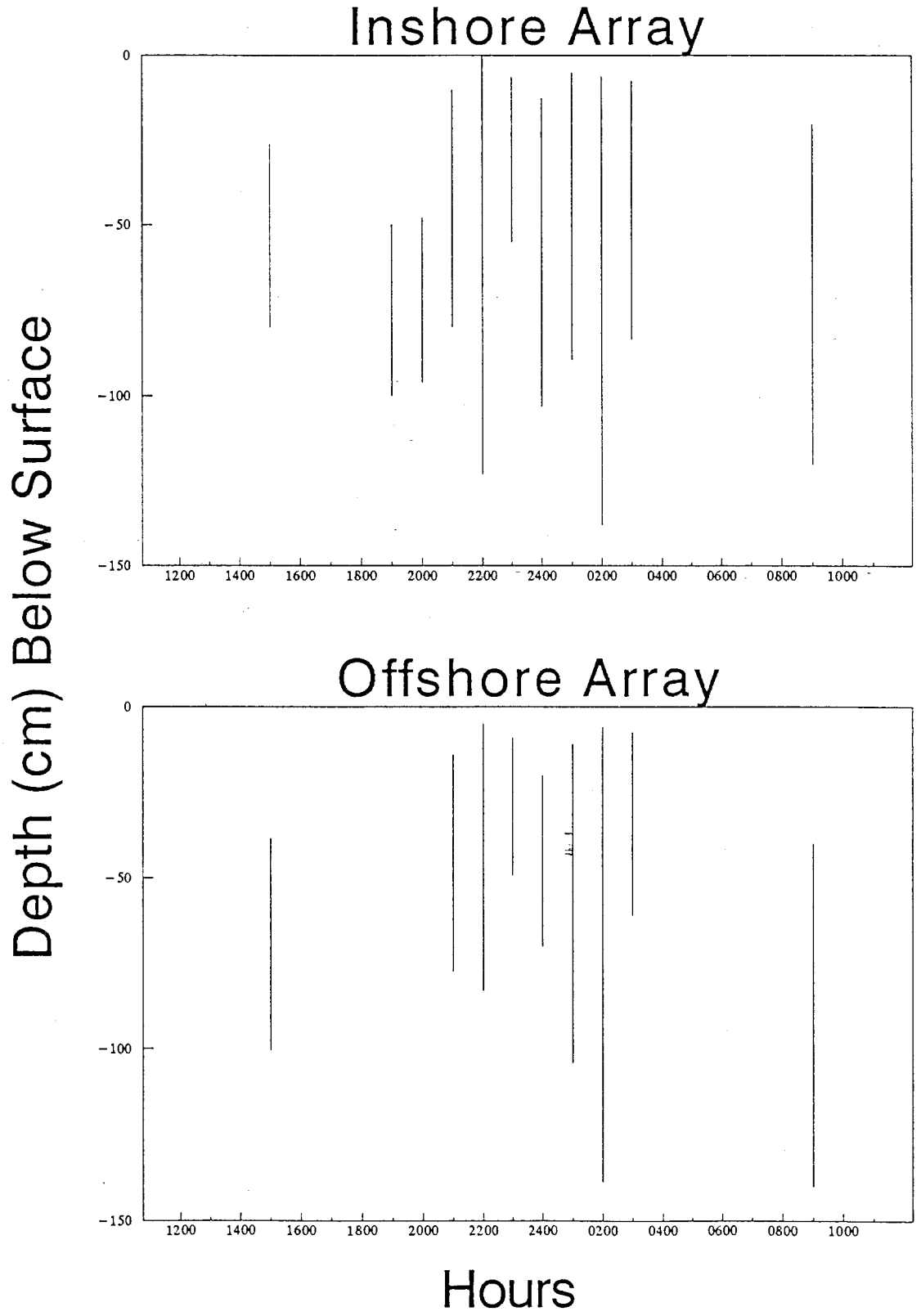

Figure 25. Depth of smolt passage data summarized by hour, Ugashik River, May 22 to June 10, 1994.