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1982 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

Edited by:
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and
Henry J. Yuen

January 1984

ALASKA DEPARTMENT OF FISH AND GAME
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Commissioner

1982 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

A summary of data collected from sockeye salmon *(Oncorhynchus nerka)* smolt programs in Bristol Bay, including Kvichak, Naknek, Egegik, Ugashik, Wood, and Nushagak-Nuyakuk Rivers

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ABSTRACT

Sockeye salmon *(Oncorhynchus nerka)* smolt projects were conducted on seven Bristol Bay rivers in 1982. Estimates of outmigrating sockeye salmon smolts were 204.0, 129.3, 60.4, and 37.0 million for the Kvichak, Naknek, Egegik, and Wood Rivers, respectively. There were no similar estimates for the Ugashik, Nushagak, and Nuyakuk Rivers. Outmigrating smolt age composition were 60% Age I and 40% Age II; 91% Age I and 9% Age II; 83% Age I, 17% Age II, and less than 1% Age III; 87% Age I and 13% Age II; 99% Age I and 1% Age II; and 100% Age I for the Kvichak, Naknek, Egegik, Ugashik, Wood, Nuyakuk, and Nushagak Rivers, respectively. Methods of smolt enumeration and sampling included sonar, fyke nets, inclined plane traps, and a beach seine.

KEY WORDS: sockeye salmon, smolt outmigration, sonar enumeration, age composition

INTRODUCTION

This Technical Data Report represents a continuation in the documentation of sockeye salmon *(Oncorhynchus nerka)* smolt data collected from various Bristol Bay river systems. In 1982 smolt projects were conducted on four systems, Kvichak, Naknek, Egegik, and Wood. Sonar biomass counters were used to estimate smolt abundance on the Kvichak, Egegik, and Wood Rivers while an inclined plane trap, a fyke net, and a beach seine were used on the Nushagak, Nuyakuk, and Ugashik Rivers, respectively. Length and weight data were collected from each age class of smolt on each of the rivers sampled. Infection rate by the cestode parasite *(Triaenophorus crassus)* was documented for smolt emigrating down the Wood River. Climatological data are presented for each smolt site. Smolt data is used to forecast returns of adults and to assist in establishing optimum escapement levels.

As used in this report, Age I smolt are those smolt which have formed one scale annulus or "check", and are in their second year of freshwater residency at the time of outmigration. Age II or two-check smolt are those in their third year of freshwater residency possessing two scale annuli.

1982 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

Total outmigration estimates of sockeye salmon smolt from the Kvichak River, in addition, to size and age composition, are used in forecasting future runs to the system and to help in evaluating escapement levels and smolt production. Estimates using sonar began in 1971 and replaced the outdated fyke net catches and outmigration indices which had begun in 1955 (Russell 1972; Paulus and McCurdy 1972; Parker 1974a and 1974b). The sonar program continued in 1982 and provided outmigration estimates, age class composition, and size information.

METHODS AND MATERIALS

Sonar Arrays

The sonar counting system consisted of three 3.2 m plastic ladder arrays, each holding 14 sonar transducers. The transducers were then connected to a single control unit by coaxial cable. Installation and operation of the sonar gear were similar, with minor exceptions, to that of 1976 (Randall 1977).

Two arrays were placed in operation on 17 May. The third array was held in reserve because of ice conditions in Iliamna Lake. Wind conditions were such that shifting of the ice did not take place and most ended up melting in place. The third array was placed in operation on 25 May once it became apparent there would be no severe ice problems. Counts for the third array prior to its being operational were interpolated from the proportion of the first two arrays during the remainder of the season.

Adjustment of Sonar Counts

The system was operational at all times and counts were electronically totaled every 15 minutes for each array and recorded on paper tape. In order to convert sonar counts into numbers of smolt it was necessary to subtract false counts, interpolate for missed time, adjust for river velocity, expand counts for river width, and multiply by 10.

The normal procedure to eliminate false counts (ice, boats, debris, etc.) was to disable the entire system. The control unit printed the number of seconds the system was disabled. If this procedure wasn't used, known false counts were subtracted from the counts printed on the paper tape. Counts during missed time were estimated by linear interpolation.

The counting rate of the control unit was dependent on water velocity. Actual water velocities were measured with a Gurley meter twice during the project. Velocities on 17 May were 4.26 feet per second (fps) at both the inshore and offshore arrays and 4.63 fps at the center array. Measurements taken on 7 June gave estimates of 4.40 fps at the inshore array, 4.95 fps at the center array, and 4.74 fps at the offshore array. The control unit was set and reset at these velocities. These velocities were used to make linear adjustments in the sonar counts.

The sonar signal from each array was approximately 3.7 m wide. The counts from each array were expanded to estimate the number of smolt migrating in sections of the river not covered by arrays. Daily counts were then expanded to estimate the total daily outmigration based on the daily lateral distribution of sonar counts over the three arrays.

The sonar system functioned as a biomass counter and was designed to register one count for the biomass equivalent to 10 smolt passing over the sonar equipped arrays (Krasnowski 1975). The final adjustment for estimating the total outmigration of smolt, therefore, was to multiply the daily counts by 10.

Age-Weight-Length Sampling

Catches from fyke net and dip net catches were used to determine mean lengths and weights and the age composition of the smolt outmigration. A standard 1.5 x 1.5 m fyke net was fished in about 1.2 m of water in approximately the same location as the index site of previous years. Dipnet catches were made at this same site during periods of peak outmigrations. Efforts were made to collect 30 smolt for age, length, and weight data at 0600, 1200, 1800, and 2400 hours daily. Samples were also taken during the middle of the above time periods for age distribution (using length frequencies) only.

Estimated age composition of the total outmigrations was weighted by the estimate for each of the sample periods. During the strong outmigration of 28 May, fifteen extra samples of 30-40 smolt each were collected by dip net to try and determine if the regular short sampling periods during this peak period would bias age apportionments.

RESULTS

Climatological and Hydrological Observations

Weather and river conditions were monitored at the sonar site from 14 May through 15 June (Table 1). Ice flowed intermittently until about 22 May. The mean air and water temperatures over the duration of the project were 8.3° C and 4.9° C, respectively. Water temperatures during smolt studies in the past 20 years have averaged 5.3° C (Appendix Table 1). During the peak of the smolt outmigration the mean water temperature was 4.3° C.

Table 1. Climatological and stream observations, Kvichak River, 14 May to 15 June 1982.

DATE	SKY 0800	SKY 2000	WIND (mph) 0800	WIND (mph) 2000	MEAN AIR TEMP (C)	MEAN WATER TEMP (C)	TURBIDITY
5/14	2	2	-	-	-	2.5	1
5/15	2	2	-	-	-	3.2	1
5/16	2	2	-	-	-	3.2	1
5/17	5	2	-	-	-	3.3	1
5/18	2	3	5NE	5E	3.5	3.4	1
5/19	2	3	2E	0	4.7	3.1	1
5/20	5	3	3SW	5SW	6.5	3.1	1
5/21	4	2	6W	10W	7.9	3.7	1
5/22	5	1	6W	10E	7.7	3.4	1
5/23	3	3	2N	2NE	5.7	4.4	1
5/24	4	3	20SW	20SW	9.6	4.2	1
5/25	4	4	0	0	4.4	4.0	1
5/26	4	2	20E	35E	5.5	4.5	5
5/27	3	4	4W	3S	8.1	3.7	5
5/28	4	2	3SW	7NE	9.2	4.0	2
5/29	4	3	7SW	7SW	9.0	4.0	1
5/30	4	2	0	2W	8.7	4.2	1
5/31	2	2	10W	5SW	10.2	4.3	1
6/01	1	4	0	10SW	9.5	4.5	1
6/02	5	3	20SW	20W	7.2	4.6	1
6/03	1	1	0	10E	9.0	5.1	1
6/04	4	4	0	3SE	11.0	4.7	1
6/05	4	4	0	4NE	8.5	6.1	5
6/06	4	4	5SW	3NE	8.0	5.8	5
6/07	3	3	0	2E	6.7	6.2	5
6/08	4	4	0	6SE	10.2	6.4	2
6/09	4	3	10N	10E	11.0	7.5	5
6/10	3	3	25NE	25E	12.0	7.2	5
6/11	3	3	40E	20E	10.0	7.1	5
6/12	4	3	6NE	12E	8.0	6.5	5
6/13	4	3	0	2E	10.0	7.1	4
6/14	2	1	15NE	8E	10.2	8.5	4
6/15	4	-	0	-	9.5	8.0	4
Mean					8.3	4.9	

Outmigration Estimate

A total of 4,572,376 sonar counts was recorded during the 1982 sonar enumeration project (Table 2). The total estimated smolt outmigration from these counts was 204.0 million (Table 3). The peak outmigration occurred on 31 May and 1 June and represented 41% of the total outmigration. A smaller peak on 28 May represented 18% of the total estimate.

The age class composition of the outmigration consisted of 122.9 million Age I smolt from the 1980 escapement of 22.5 million and 81.1 million Age II smolt from the 1979 escapement of 11.2 million (Table 4). The 81.1 million Age II smolt in addition to the 163.0 million Age I smolt from 1981 outmigration indicated a total production of 21.5 smolt per spawner from the 1979 brood year. Average marine survival for Age I smolt, from brood year 1968 through brood year 1977, was 9.8%, while that for Age II smolt was 13.3% (Appendix Table 2).

Age-Weight-Length

A total of 1,338 smolt was sampled to determine mean weight, length, and age. Daily mean weights and lengths are presented in Table 5. Mean lengths were 84.3 mm for Age I smolt and 102.7 for Age II smolt. Mean weights for Age I and Age II smolts were 5.1 g and 9.1 g, respectively. Historical data on age composition, mean weights, and mean lengths is provided in Table 6. The estimated age composition of the total outmigration was 60% Age I and 40% Age II. Additional samples taken on 28 May using a dip net resulted in individual samples varying from 3.4% to 100% Age I smolt. The total composition of all the special 15 samples combined was 70% Age I and 30% Age II. Age I smolt length was the second lowest since 1964 while Age II smolt length was the third lowest.

Table 2. Kvichak River sockeye salmon smolt counts by array, less false counts, plus interpolation for missed time, 1982.

DATE	INSHORE	CENTER	OFFSHORE	TOTAL
5 17	13	63	50	126
5 18	42	93	260	395
5 19	51	256	178	485
5 20	69	309	258	636
5 21	227	1,047	819	2,093
5 22	759	5,088	1,178	7,025
5 23	1,011	5,797	3,385	10,193
5 24	369	2,615	996	3,980
5 25	43,378	122,122	51,715	217,215
5 26	2,911	2,622	128	5,661
5 27	23,526	42,557	32,734	98,817
5 28	109,204	321,629	444,023	874,856
5 29	18,722	105,323	171,353	295,398
5 30	3,092	9,657	6,271	19,020
5 31	166,209	418,896	782,057	1,367,162
6 1	51,738	130,833	314,508	497,079
6 2	11,663	57,880	43,149	112,692
6 3	31,192	76,004	119,894	227,090
6 4	5,729	21,327	49,604	76,660
6 5	1,584	2,855	2,354	6,793
6 6	1,866	3,636	3,735	9,237
6 7	14,183	103,623	54,090	171,896
6 8	29,875	35,973	170,996	236,844
6 9	1,016	10,577	14,575	26,168
6 10	1,108	4,917	16,198	22,223
6 11	2,660	51,507	132,844	187,011
6 12	8,923	39,200	33,907	82,030
6 13	590	2,324	2,301	5,215
6 14	817	3,056	4,503	8,376
TOTAL	532,527	1,581,786	2,458,063	4,572,376
% OF TOTAL	11.65	34.59	53.76	

Table 3. Daily smolt outmigration estimate by age class with percent age composition and accumulated totals, Kvichak River, 1982.

DATE	AGE I	%	ACCUM	AGE II	%	ACCUM	TOTAL	ACCUM
5 17	1,748	.32	1,748	3,656	.68	3,656	5,405	5,405
5 18	5,570	.32	7,319	11,647	.68	15,304	17,218	22,623
5 19	6,716	.32	14,035	14,043	.68	29,347	20,759	43,383
5 20	8,824	.32	22,860	18,451	.68	47,798	27,275	70,659
5 21	29,014	.32	51,874	60,665	.68	108,464	89,680	160,339
5 22	96,000	.32	147,875	200,729	.68	309,193	296,730	457,069
5 23	140,969	.32	288,845	294,755	.68	603,949	435,725	892,794
5 24	54,811	.32	343,656	114,605	.68	718,554	169,416	1,062,210
5 25	2,939,020	.32	3,282,677	6,145,225	.68	6,863,779	9,084,246	10,146,456
5 26	71,682	.32	3,354,360	149,882	.68	7,013,661	221,565	10,368,022
5 27	1,337,015	.32	4,691,376	2,795,578	.68	9,809,240	4,132,594	14,500,616
5 28	12,186,749	.32	16,878,125	25,481,383	.68	35,290,623	37,668,132	52,168,748
5 29	4,172,935	.32	21,051,060	8,725,228	.68	44,015,851	12,898,163	65,066,912
5 30	550,979	.68	21,602,039	253,929	.32	44,269,781	804,908	65,871,821
5 31	40,479,760	.68	62,081,800	18,655,888	.32	62,925,670	59,135,649	125,007,470
6 1	16,180,199	.68	78,262,000	7,456,961	.32	70,382,631	23,637,161	148,644,631
6 2	3,578,477	.68	81,840,477	1,649,211	.32	72,031,842	5,227,688	153,872,319
6 3	9,347,456	.88	91,187,933	1,276,001	.12	73,307,844	10,623,457	164,495,777
6 4	3,228,774	.88	94,416,708	440,753	.12	73,748,597	3,669,528	168,165,305
6 5	269,696	.88	94,686,404	36,815	.12	73,785,413	306,511	168,471,817
6 6	371,068	.88	95,057,473	50,653	.12	73,836,066	421,722	168,893,539
6 7	6,994,948	.88	102,052,421	954,865	.12	74,790,932	7,949,814	176,843,354
6 8	9,957,748	.88	112,010,170	1,359,311	.12	76,150,243	11,317,059	188,160,414
6 9	859,051	.69	112,869,221	390,478	.31	76,540,722	1,249,529	189,409,943
6 10	740,396	.69	113,609,618	336,543	.31	76,877,265	1,076,940	190,486,884
6 11	6,258,219	.69	119,867,838	2,844,645	.31	79,721,911	9,102,865	199,589,749
6 12	2,621,654	.69	122,489,492	1,191,661	.31	80,913,572	3,813,315	203,403,065
6 13	167,005	.69	122,656,497	75,911	.31	80,989,483	242,916	203,645,981
6 14	271,587	.69	122,928,085	123,448	.31	81,112,932	395,035	204,041,017

Table 4. Comparative Kvichak River sockeye salmon escapement, smolt production, age class composition, and smolt per spawner data, 1956-1980.

BROOD YEAR	ESCAPEMENT	ESTIMATED SMOLT PRODUCTION AGE I	AGE II	AGE III	TOTAL	AGE PROPORTION AGE I	AGE II	AGE III	SMOLT PER SPAWNER
1956	9,443,318	3,267,274	2,777,960	0	6,045,234	.54	.46	0.00	.640
1957	2,842,810	85,916	552,603	0	638,519	.13	.87	0.00	.225
1958	534,785	61,400	10,126	0	71,526	.86	.14	0.00	.134
1959	680,000	26,038	72,180	0	98,218	.27	.73	0.00	.144
1960	14,630,000	1,130,820	4,116,093	0	5,246,913	.22	.78	0.00	.359
1961	3,705,849	113,338	1,603,464	0	1,716,802	.07	.93	0.00	.463
1962	2,580,884	458,122	1,748,178	0	2,206,300	.21	.79	0.00	.855
1963	338,760	64,377	23,377	0	87,754	.73	.27	0.00	.259
1964	957,120	252,384	222,528	0	474,912	.53	.47	0.00	.496
1965	24,325,926	2,866,214	5,475,362	0	8,341,576	.34	.66	0.00	.343
1966	3,775,184	648,321	541,017	0	1,189,338	.55	.45	0.00	.315
1967	3,216,208	594,327	298,282	0	892,609	.67	.33	0.00	.278
1968	2,557,440	185,356	5,959,383 [1]	0	6,144,739	.03	.97	0.00	2.403 [2]
1969	8,394,204	85,723,430 [1]	67,004,325	0	152,727,755	.56	.44	0.00	18.194
1970	13,935,306	570,750	189,138,158	4,925,610	194,634,518	.00	.97	.03	13.967
1971	2,387,392	4,987,961	33,767,464	0	38,755,425	.13	.87	0.00	16.233
1972	1,009,962	4,021,849	5,784,036	0	9,805,885	.41	.59	0.00	9.709
1973	226,554	9,848,495	2,927,804	0	12,776,299	.77	.23	0.00	56.394
1974	4,433,844	99,890,123	132,920,297	0	232,810,420	.43	.57	0.00	52.508
1975	13,140,450	82,097,299	238,523,253	0	320,620,552	.26	.74	0.00	24.400
1976	1,965,282	31,305,140	25,993,357	0	57,298,497	.55	.45	0.00	29.155
1977	1,341,144	26,623,136	10,109,539	0	36,732,675	.72	.28	0.00	27.389
1978	4,149,288	162,563,957	20,653,073	0	183,217,030	.89	.11	0.00	44.156
1979	11,218,434	162,958,121	81,112,932	0	243,976,889	.67	.33	0.00	21.479
1980	22,505,268	122,928,085	0	0	122,928,085	1.00	0.00	0.00	5.462

[1] Begin use of sonar.

[2] Based on Age I counts estimated with fyke nets and Age II counts estimated with sonar.

Table 5. Mean length (mm), mean weight (g), standard error, and sample size (n) for sockeye salmon smolt by age class and sample date, Kvichak River, 1982.

	AGE I					AGE II					AGE III				
DATE	MEAN LENGTH	S.E.	MEAN WEIGHT	S.E.	N	MEAN LENGTH	S.E.	MEAN WEIGHT	S.E.	N	MEAN LENGTH	S.E.	MEAN WEIGHT	S.E.	N
5/17	0.	0.	0.	0.	0	108.71	2.81	11.01	1.05	7	0.	0.	0.	0.	0
5/18	81.00	18.38	5.55	2.90	2	109.75	1.71	11.40	0.43	4	0.	0.	0.	0.	0
5/19	85.00	0.	6.40	0.	1	106.65	5.74	11.04	1.43	17	0.	0.	0.	0.	0
5/21	88.14	1.35	5.97	0.55	7	110.48	4.94	11.50	1.58	23	0.	0.	0.	0.	0
5/22	0.	0.	0.	0.	0	107.48	3.96	10.69	0.93	23	0.	0.	0.	0.	0
5/23	88.24	4.34	6.00	0.89	17	106.02	7.64	10.50	2.02	43	0.	0.	0.	0.	0
5/24	86.32	4.01	5.62	0.88	19	93.36	3.38	7.16	0.78	11	0.	0.	0.	0.	0
5/26	89.38	2.96	6.42	0.71	13	108.53	4.06	10.96	1.16	17	0.	0.	0.	0.	0
5/27	89.25	3.77	5.98	0.98	4	107.15	4.68	9.96	1.24	26	0.	0.	0.	0.	0
5/28	0.	0.	0.	0.	0	104.80	4.21	9.33	1.16	30	0.	0.	0.	0.	0
5/29	85.21	4.21	5.16	0.84	58	107.94	7.30	10.24	1.92	82	0.	0.	0.	0.	0
5/30	84.90	4.66	4.94	0.61	20	96.60	9.59	7.25	2.01	10	0.	0.	0.	0.	0
5/31	82.98	11.07	5.45	1.08	53	103.41	5.45	9.39	1.52	37	0.	0.	0.	0.	0
6/1	83.98	3.59	4.96	0.70	83	101.68	5.82	8.20	1.21	37	0.	0.	0.	0.	0
6/2	85.36	3.39	5.32	0.77	74	99.95	7.42	8.26	1.69	22	0.	0.	0.	0.	0
6/3	84.13	2.50	4.99	0.51	55	101.40	5.68	8.06	1.07	5	0.	0.	0.	0.	0
6/4	84.27	3.31	4.84	0.64	78	100.90	4.20	8.26	1.05	10	0.	0.	0.	0.	0
6/5	83.96	3.50	4.83	0.55	27	101.00	4.36	8.43	1.70	3	0.	0.	0.	0.	0
6/6	81.94	3.02	4.88	0.49	53	101.14	10.12	8.54	1.90	7	0.	0.	0.	0.	0
6/7	83.55	3.81	4.99	0.66	49	102.73	4.03	8.60	0.98	11	0.	0.	0.	0.	0
6/8	83.58	2.89	4.65	0.51	53	98.00	7.81	7.19	1.59	7	0.	0.	0.	0.	0
6/9	82.98	2.37	4.66	0.45	48	96.17	4.76	7.52	1.21	12	0.	0.	0.	0.	0
6/10	83.48	3.36	4.67	0.68	23	92.14	7.29	6.34	1.65	7	0.	0.	0.	0.	0
6/12	84.88	3.22	5.03	0.58	50	101.35	6.45	8.19	1.56	40	0.	0.	0.	0.	0
6/13	84.05	4.42	5.07	0.65	44	100.06	8.00	8.10	1.71	16	0.	0.	0.	0.	0
SEASONAL MEAN	84.27		5.06			102.70		9.05			0.		0.		

Table 6. Comparative age, length, weight, and outmigration estimate of sockeye salmon smolt from the Kvichak River,1955-1982.

YEAR OF SEAWARD MIGRATION	AGE I %	AGE I LENGTH (mm)	AGE I WT (g)	AGE II %	AGE II LENGTH (mm)	AGE II WT (g)	AGE III %	AGE III LENGTH (mm)	AGE III WT (g)	OUT MIGRATION ESTIMATE
1955	.07	89.0	0.0	.93	0.0	0.0	0.00	0.0	0.0	260,068
1956	.39	92.0	0.0	.61	116.0	0.0	0.00	0.0	0.0	77,660
1957	.72	96.0	7.3	.28	120.0	14.4	0.00	0.0	0.0	30,907
1958	.98	84.0	4.6	.02	114.0	0.0	0.00	0.0	0.0	3,333,953
1959	.03	80.0	0.0	.97	99.0	7.6	0.00	0.0	0.0	2,863,876
1960	.10	91.0	6.3	.90	108.0	10.3	0.00	0.0	0.0	614,003
1961	.72	92.0	6.8	.28	117.0	13.1	0.00	0.0	0.0	36,164
1962	.94	82.0	4.3	.06	110.0	9.9	0.00	0.0	0.0	1,203,000
1963	.03	83.0	4.8	.97	98.0	7.5	0.00	0.0	0.0	4,229,431
1964	.22	87.0	5.2	.78	108.0	9.8	0.00	0.0	0.0	2,061,586
1965	.04	90.0	6.8	.96	109.0	11.3	0.00	0.0	0.0	1,812,555
1966	.92	94.0	7.4	.08	114.0	12.6	0.00	0.0	0.0	275,761
1967	.93	86.0	5.9	.07	118.0	14.2	0.00	0.0	0.0	3,088,742
1968	.11	88.0	5.5	.89	104.0	9.2	0.00	0.0	0.0	6,123,683
1969	.52	92.5	5.7	.48	109.3	10.6	0.00	0.0	0.0	1,135,344
1970	.38	90.8	6.0	.62	110.2	11.0	0.00	0.0	0.0	483,638
1971	.93	89.9	5.8	.07	111.0	11.1	0.00	0.0	0.0	91,682,813 [1]
1972	.01	80.0	4.2	.99	106.0	10.0	0.00	0.0	0.0	67,575,075
1973	.03	85.6	5.1	.97	97.1	8.3	0.00	0.0	0.0	194,126,119
1974	.09	95.5	8.3	.79	111.0	13.1	.12	123.5	17.5	42,714,923
1975	.63	97.7	8.4	.37	121.9	16.4	0.00	0.0	0.0	15,632,531
1976	.97	88.2	5.8	.03	120.8	14.2	0.00	0.0	0.0	102,817,927
1977	.38	86.0	5.5	.62	106.0	10.1	0.00	0.0	0.0	215,017,596
1978	.12	88.1	6.0	.88	96.9	7.8	0.00	0.0	0.0	269,828,393
1979	.51	89.6	6.0	.49	108.9	10.3	0.00	0.0	0.0	52,616,493
1980	.94	88.4	5.9	.06	109.9	10.7	0.00	0.0	0.0	172,673,496
1981	.89	85.3	5.4	.11	108.3	10.2	0.00	0.0	0.0	183,611,194
1982	.60	84.3	5.1	.40	102.7	9.1	0.00	0.0	0.0	204,041,017

[1] Begin outmigration estimate with sonar.

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Appendix Table 1. Water temperature (°C) during smolt studies, Kvichak River, 1963 to 1982.

Year	Start	End	Minimum	Maximum	Mean
1963	5/16	6/14	2.22	8.89	5.5
1964	5/18	6/14	0.00	5.6	2.6
1965	5/17	6/11	0.00	8.9	4.4
1966	5/16	6/26	0.00	11.1	4.7
1967	5/17	6/20	1.1	9.4	6.9
1968	5/12	6/12	3.3	8.3	5.4
1969	5/16	6/18	0.3	7.8	3.9
1970	5/13	6/07	2.8	11.1	6.8
1971	5/17	6/20	1.1	3.3	2.4
1972	5/18	6/18	0.6	5.0	2.9
1973	5/15	6/14	2.9	8.9	4.9
1974	5/13	6/09	3.0	8.0	6.2
1975	5/17	6/15	2.0	8.0	3.8
1976	5/18	6/19	2.0	9.5	3.9
1977	5/17	6/14	3.0	9.5	6.4
1978	5/19	6/09	5.0	11.0	7.6
1979	6/01	6/10	8.0	10.0	8.6
1980	5/16	6/18	1.5	9.0	5.5
1981	5/15	6/09	7.0	10.0	8.2
1982	5/14	6/15	2.5	8.5	4.9
Mean					5.3

Appendix Table 2. Kvichak River sockeye salmon escapement, smolt estimate, adult returns, and smolt survival by brood year, 1968-1980.

		AGE I			AGE II		
BROOD YEAR	TOTAL ESCAPEMENT	EST SMOLT	ADULT RETURN	ADULT/ SMOLT	EST SMOLT	ADULT RETURN	ADULT/ SMOLT
1968	2,557,440		297,060		5,959,383	256,674	.04
1969	8,394,204	85,723,430	436,165	.01	67,004,325	4,686,786	.07
1970	13,935,306	570,750	54,194	.09	189,138,158	15,470,634	.08
1971	2,387,392	4,987,961	338,421	.07	33,767,464	2,389,971	.07
1972	1,009,962	4,021,849	397,356	.10	5,784,036	1,493,646	.26
1973	226,554	9,848,495	1,534,974	.16	2,927,804	806,201	.28
1974	4,433,844	99,890,123	8,217,356	.08	132,920,297	17,122,546	.13
1975	13,140,450	82,097,299	6,744,805	.08	238,523,253	28,802,859	.12
1976	1,965,282	31,305,140	5,847,312	.19	25,993,357	4,011,504	.15
1977	1,341,144	26,623,136	2,687,468	.10	10,109,539	186,748	.02[2]
1978	4,149,288	162,563,957	1,712,532	.01[1]	20,653,073		
1979	11,218,434	162,958,121			81,112,932		
1980	22,505,268	122,928,085					
MEAN				0.098[3]			.133[4]

[1] Excludes 1983 returns of Age 5_2 adults.

[2] Excludes 1983 returns of Age 6_3 adults.

[3] Brood years 1969 through 1977 only.

[4] Brood years 1968 through 1976 only.

1982 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

The Naknek River sockeye salmon smolt project was reinstituted in 1982 to collect information on the timing, magnitude, age composition, and average body size of the outmigration. This information will be used to monitor Naknek system sockeye production and to forecast future returns to that system. Sonar biomass counters were used to generate a total outmigration estimate for 1982, replacing the fyke net index program conducted from 1956-1977.

METHODS AND MATERIALS

Sonar Arrays

The sonar counting system consisted of three 3.05 m long arrays connected to a single shorebound control unit capable of processing signals from all three arrays simultaneously. Each array was independently anchored, housed 10 upward-facing transducers, and sonified roughly 3.35 meters of river width. Installation of the sonar arrays closely followed the procedure described by Randall (1977) except three 300 to 500 pound "permanent" anchors were placed in the river to hold the arrays at 13.7 m, 35.0 m, and 57.9 m from the east bank, respectively.

The arrays were first placed in the Naknek River on 23 May and data collection began on 24 May. All three arrays started counting at the time and operated normally throughout the duration of the project which ended on 10 July.

Adjustment of Sonar Counts

The sonar system was monitored continuously throughout the project. All returned echoes were automatically tallied and printed every 7-1/2 to 15 minutes. The tallied raw counts were summed to generate hourly counts, and any known false counts caused by boat traffic, ice, heavy rain, wind, etc. were subtracted. Raw counts were then expanded for the amount of time the system was disabled, generating the adjusted counts of smolt biomass passing directly over each of the arrays.

The counting rate of the sonar control unit is a function of the speed at which the smolt travel over the arrays. That speed in turn depends largely upon water velocity. Water velocities were taken directly over Arrays I, II, and III at

the onset of counting, and found to be 0.914, 1.042, and 0.905 meters per second, respectively. Because the Naknek River is tidally influenced at the sonar site, a Gurley-type flowmeter was "permanently" installed in the river directly behind Array I, or the inshore array. This allowed continuous water velocity readings, and the counting unit was reset immediately after each printing interval. Later, daily counts from Arrays II and III were adjusted for differences between the relative water velocities over each of them and that over Array I. Factors of 1.14 and 0.99 were used to adjust the counts from Arrays II and III, respectively.

After the counts from each array had been correctly adjusted it was necessary to estimate the amount of smolt outmigrating in the area of the river not sampled by the counter. This was accomplished by dividing the counts by the estimated proportion of the smolt lateral distribution sampled by the particular array. The periphery of smolt distribution along each bank was determined visually since the side scanning sonar normally used for the task was completely inoperative. All counts appropriately adjusted were summed into hourly, and these in turn were summed into daily counts.

Once daily counts of smolt biomass were estimated, final adjustments were required to estimate the actual numbers of outmigrating smolt. The Naknek River sonar system was designed to register one count for the biomass equivalent of five smolt. A manufacturing defect caused the system to be exactly twice as sensitive as planned, however, registering one count for the biomass equivalent of 2.5 smolt. Additionally, smolt outmigrating in 1982 were significantly larger than anticipated in the system design criteria. The correction factor for Naknek River mean smolt size in 1982 was given by the manufacturer as 0.645. Adjusted daily counts were, therefore, divided by 2.0 and then multiplied by 0.645 to generate final daily outmigration estimates.

Age-Weight-Length Sampling

Sockeye smolt were collected in fyke nets four times daily to determine the mean length, weight, and age composition of the Naknek River outmigration. Catches were made at 0600, 1200, 1800, and 2400 hours whenever possible from which thirty smolt each were randomly sampled. Sample age compositions, mean lengths, and mean weights were appropriately weighted by the corresponding outmigration estimates to yield daily values. Seasonal means were generated by weighting daily means by corresponding daily outmigration estimates.

Sonar Count Comparisons

The sonar system used during the 1982 Naknek River smolt investigations was new and identical to one developed for the Egegik River smolt project this year. Differences in outmigration timing between the two rivers allowed both systems to be used simultaneously in the Naknek River for counting comparison. One Egegik River sonar array was positioned 7 m directly behind the center Naknek array, and was connected to the Egegik smolt counter. Both systems operated simultaneously for 10 days. Only data from the last 6 days were evaluated because the trailing Egegik array did not appear to be resting solidly on the bottom for the first 4 days.

RESULTS

Climatological and Hydrological Observations

Daily weather and hydrologic observations were taken from 21 May through 10 July and are presented in Table 1. Maximum, minimum, and mean seasonal water temperatures were 14.4, 5.0, and 8.9°C, respectively. The 1982 mean water temperature was somewhat colder than the 10.6°C average of all water temperatures reported from previous Naknek River smolt investigations (Appendix Table 1). River temperatures averaged 9.0°C during peak outmigrations on 11 June.

Outmigration Estimate

The Naknek River sonar counter tallied some 11,163,683 raw counts of smolt biomass from 24 May through 10 July 1982 (Table 2). Roughly 10% of the counts were registered over Array I, 52% over Array II, and 38% over Array III. The raw counts led to an estimated 129,316,110 smolt having outmigrated during the course of the project; the expanded daily outmigration estimate by day is presented in Table 3 and illustrated in Figure 1. Of these smolt, some 115.6 million were Age I's from the 1980 escapement of 2.64 million and the remaining 12.9 million Age II's were from the 1979 escapement of 925 thousand (Table 4).

Age-Weight-Length

In all, some 3,222 smolt were sampled for length, weight, and age. Daily mean lengths, weights, and sample size by age class are presented in Table 5. The estimated seasonal mean lengths of Age I and Age II smolt were 93.9 and 100.1 mm, respectively, and average weights were 8.2 and 14.7 g, respectively. Seasonal age composition in 1982 was 90.6% Age I and 9.4% Age II. Appendix Table 2 lists all available length and weight data collected on Naknek River sockeye smolt since 1955 for comparison.

Sonar Count Comparisons

Counts tallied by the Naknek counter were always higher than those registered on the Egegik counter (Table 6). The relationship between the counts registered on each machine was linear, and counts registered on the Egegik counter as a function of Naknek counts in the same area of river on the Naknek unit were:

$$y = 3146.31 + 0.69X$$

where: x = Naknek counts

Y = Egegik counts

$r^2 = 0.99$

Table 1. Climatological and stream observations, Naknek River, 21 May to 9 July 1982.

DATE	SKY 0800	SKY 2000	WIND (mph) 0800	WIND (mph) 2000	MEAN AIR TEMP (C)	MEAN WATER TEMP (C)	TURBIDITY
5/21	-	-	-	-	-	6.0	1
5/22	5	2	0	10NW	6.5	7.0	1
5/23	3	3	5NW	10NW	8.0	6.0	1
5/24	4	4	10SW	10SW	1.3	-	1
5/25	1	4	5SE	5SE	4.0	5.0	1
5/26	2	-	15SW	-	11.0	5.5	1
5/27	4	4	20SW	25SW	-	7.3	5
5/28	3	3	10SW	15SW	8.5	7.0	5
5/29	4	-	5SW	-	-	-	2
5/30	3	4	0	5SW	15.0	8.1	2
5/31	0	2	-	3SW	10.5	9.4	2
6/01	4	-	0	0	-	6.3	1
6/02	4	4	15SW	15SW	9.0	7.8	1
6/03	4	4	0	5SW	13.5	6.3	1
6/04	1	1	0	12SW	16.5	7.0	1
6/05	4	4	15SW	20SW	9.0	7.2	2
6/06	3	4	12SW	5SW	9.0	8.5	4
6/07	4	3	3SW	5SW	8.0	7.8	1
6/08	4	1	3SW	0	16.5	8.3	1
6/09	4	-	0	0	8.0	9.4	1
6/10	4	-	3NE	0	9.0	9.4	1
6/11	4	-	-	15E	9.0	9.4	1
6/12	2	4	7E	-	10.5	7.6	1
6/13	3	3	2E	0	10.3	10.0	1
6/14	3	3	0	5W	14.0	10.0	1
6/15	3	-	0	0	10.0	10.0	1
6/16	3	-	0	0	-	7.7	1
6/17	2	-	0	0	14.0	7.8	1
6/18	1	-	-	-	11.5	12.2	1
6/19	-	2	0	0	11.0	14.4	1
6/20	2	3	-	-	8.3	-	1
6/21	3	4	-	15SW	8.8	13.3	1
6/22	2	2	0	0	9.0	12.2	2
6/23	-	2	5E	0	12.0	12.0	1
6/24	4	4	-	-	15.0	11.2	1
6/25	2	-	0	0	12.0	-	1
6/26	-	-	-	-	-	-	-
6/27	2	-	0	0	-	-	1
6/28	4	-	0	0	9.0	-	2
6/29	4	-	0	0	6.0	-	2
6/30	4	4	-	0	8.0	-	5
7/01	-	-	-	-	-	-	-
7/02	3	-	7SE	-	-	-	5
7/03	4	4	22SE	15SE	11.2	-	5
7/04	4	3	10SE	0	8.5	-	5
7/05	4	4	-	15NW	8.0	-	5
7/06	1	-	0	-	-	-	5
7/07	1	1	17SE	5SW	13.2	-	5
7/08	3	3	5NE	7NE	10.0	-	5
7/09	4	1	-	0	13.3	-	5
7/10	4	-	0	-	-	-	5
MEAN					10.2	8.9	

Table 2. Naknek River sockeye salmon smolt counts by array, less false counts, plus interpolation for missed time, 1982.

DATE	INSHORE	CENTER	OFFSHORE	TOTAL
5 24	11,278	4,085	3,735	19,098
5 25	13,666	9,952	9,282	32,900
5 26	19,471	10,301	15,075	44,847
5 27	12,231	36,278	74,255	122,764
5 28	71,488	69,083	110,420	250,991
5 29	17,048	31,514	54,326	102,888
5 30	5,595	9,068	16,146	30,809
5 31	29,591	63,831	42,397	135,819
6 1	45,058	175,606	142,415	363,079
6 2	57,055	139,541	150,687	347,283
6 3	21,424	52,577	105,846	179,847
6 4	27,850	359,189	359,633	746,672
6 5	11,584	196,332	220,926	428,842
6 6	7,576	27,398	38,713	73,687
6 7	22,533	393,180	201,851	617,564
6 8	16,219	23,913	18,805	58,937
6 9	11,588	47,526	56,493	115,607
6 10	43,928	488,620	280,710	813,258
6 11	72,000	472,160	481,679	1,025,839
6 12	19,887	279,256	239,367	538,510
6 13	21,905	280,542	174,912	477,359
6 14	28,083	97,607	99,406	225,096
6 15	14,847	147,823	92,450	255,120
6 16	30,737	116,745	145,637	293,119
6 17	9,915	40,324	35,725	85,964
6 18	26,301	41,005	66,042	133,348
6 19	22,250	30,545	71,323	124,118
6 20	13,853	18,825	33,476	66,154
6 21	13,547	82,134	49,037	144,718
6 22	28,621	76,557	72,393	177,571
6 23	12,838	30,945	31,178	74,961
6 24	9,363	33,003	41,174	83,540
6 25	14,240	16,728	12,051	43,019
6 26	17,680	33,767	25,229	76,676
6 27	11,756	89,419	9,174	110,349
6 28	15,246	67,217	112,691	195,154
6 29	12,786	139,752	98,702	251,240
6 30	26,675	43,954	32,012	102,641
7 1	16,973	119,011	71,395	207,379
7 2	12,686	302,281	87,515	402,482
7 3	21,044	249,195	63,302	333,541
7 4	23,284	86,674	58,725	168,683
7 5	86,521	169,178	65,125	320,824
7 6	10,507	122,890	38,860	172,257
7 7	13,907	178,451	23,749	216,107
7 8	45,561	234,521	14,880	294,962
7 9	10,739	21,811	13,641	46,191
7 10	4,658	20,002	7,209	31,869
TOTAL	1,113,593	5,780,316	4,269,774	11,163,683
% OF TOTAL	9.98	51.78	38.25	

Table 3. Daily smolt outmigration estimate by age class with percent age composition and accumulated totals, Naknek River, 1982.

DATE	AGE I	%	ACCUM	AGE II	%	ACCUM	TOTAL	ACCUM
5 24	129,400	.73	129,400	46,861	.27	46,861	176,261	176,261
5 25	242,536	.73	371,936	87,831	.27	134,693	330,367	506,629
5 26	327,465	.73	699,401	118,588	.27	253,281	446,053	952,682
5 27	1,034,991	.73	1,734,393	374,811	.27	628,093	1,409,803	2,362,486
5 28	1,959,578	.73	3,693,971	709,641	.27	1,337,734	2,669,219	5,031,705
5 29	844,721	.73	4,538,693	305,907	.27	1,643,642	1,150,629	6,182,335
5 30	251,264	.73	4,789,958	90,993	.27	1,734,635	342,257	6,524,593
5 31	1,186,594	.80	5,976,553	302,854	.20	2,037,489	1,489,449	8,014,043
6 1	3,296,570	.80	9,273,123	841,384	.20	2,878,873	4,137,954	12,151,997
6 2	3,099,337	.80	12,372,461	791,044	.20	3,669,918	3,890,381	16,042,379
6 3	1,632,559	.80	14,005,020	416,678	.20	4,086,596	2,049,237	18,091,616
6 4	8,313,255	.94	22,318,276	492,423	.06	4,579,019	8,805,678	26,897,295
6 5	4,792,410	.94	27,110,686	283,871	.06	4,862,890	5,076,281	31,973,576
6 6	798,577	.94	27,909,264	47,302	.06	4,910,193	845,880	32,819,457
6 7	6,432,815	.88	34,342,079	865,232	.12	5,775,425	7,298,047	40,117,505
6 8	555,651	.88	34,897,730	74,736	.12	5,850,162	630,387	40,747,892
6 9	1,171,489	.88	36,069,220	157,568	.12	6,007,730	1,329,058	42,076,951
6 10	8,410,428	.88	44,479,648	1,131,226	.12	7,138,957	9,541,655	51,618,606
6 11	10,410,907	.87	54,890,556	1,530,037	.13	8,668,995	11,940,945	63,559,552
6 12	5,540,142	.87	60,430,699	814,206	.13	9,483,201	6,354,348	69,913,900
6 13	4,897,781	.87	65,328,480	719,801	.13	10,203,003	5,617,583	75,531,484
6 14	2,348,563	.92	67,677,044	214,653	.08	10,417,657	2,563,217	78,094,701
6 15	2,737,438	.92	70,414,482	250,196	.08	10,667,853	2,987,634	81,082,336
6 16	3,081,462	.92	73,495,945	281,639	.08	10,949,492	3,363,101	84,445,437
6 17	900,674	.92	74,396,620	82,319	.08	11,031,812	982,994	85,428,432
6 18	1,317,115	.89	75,713,735	154,954	.11	11,186,767	1,472,070	86,900,502
6 19	1,234,170	.89	76,947,905	145,196	.11	11,331,963	1,379,366	88,279,869
6 20	649,949	.89	77,597,855	76,464	.11	11,408,428	726,414	89,006,284
6 21	1,495,192	.89	79,093,048	175,905	.11	11,584,333	1,671,098	90,677,382
6 22	1,893,671	.95	80,986,720	98,749	.05	11,683,083	1,992,421	92,669,803
6 23	795,951	.95	81,782,671	41,506	.05	11,724,589	837,458	93,507,261
6 24	908,338	.95	82,691,010	47,367	.05	11,771,957	955,705	94,462,967
6 25	426,800	.95	83,117,810	22,256	.05	11,794,213	449,056	94,912,024
6 26	794,668	.95	83,912,479	41,439	.05	11,835,653	836,108	95,748,132
6 27	1,208,238	.95	85,120,717	63,006	.05	11,898,659	1,271,244	97,019,377
6 28	2,149,476	.95	87,270,193	112,089	.05	12,010,749	2,261,565	99,280,942
6 29	2,877,278	.98	90,147,472	72,536	.02	12,083,285	2,949,814	102,230,757
6 30	1,078,148	.98	91,225,620	27,180	.02	12,110,465	1,105,328	103,336,086
7 1	2,346,821	.98	93,572,441	59,163	.02	12,169,629	2,405,984	105,742,071
7 2	4,654,200	.98	98,226,642	117,332	.02	12,286,961	4,771,532	110,513,603
7 3	3,809,865	.98	102,036,507	96,046	.02	12,383,008	3,905,912	114,419,516
7 4	1,865,355	.98	103,901,863	47,025	.02	12,430,034	1,912,380	116,331,897
7 5	3,312,254	.96	107,214,117	132,490	.04	12,562,524	3,444,744	119,776,641
7 6	1,940,471	.96	109,154,589	77,618	.04	12,640,143	2,018,090	121,794,732
7 7	2,434,333	.96	111,588,922	97,373	.04	12,737,517	2,531,706	124,326,439
7 8	3,204,632	.96	114,793,555	128,185	.04	12,865,702	3,332,817	127,659,257
7 9	484,112	.96	115,277,667	19,364	.04	12,885,066	503,477	128,162,734
7 10	346,728	.96	115,624,396	13,869	.04	12,898,936	360,597	128,523,332

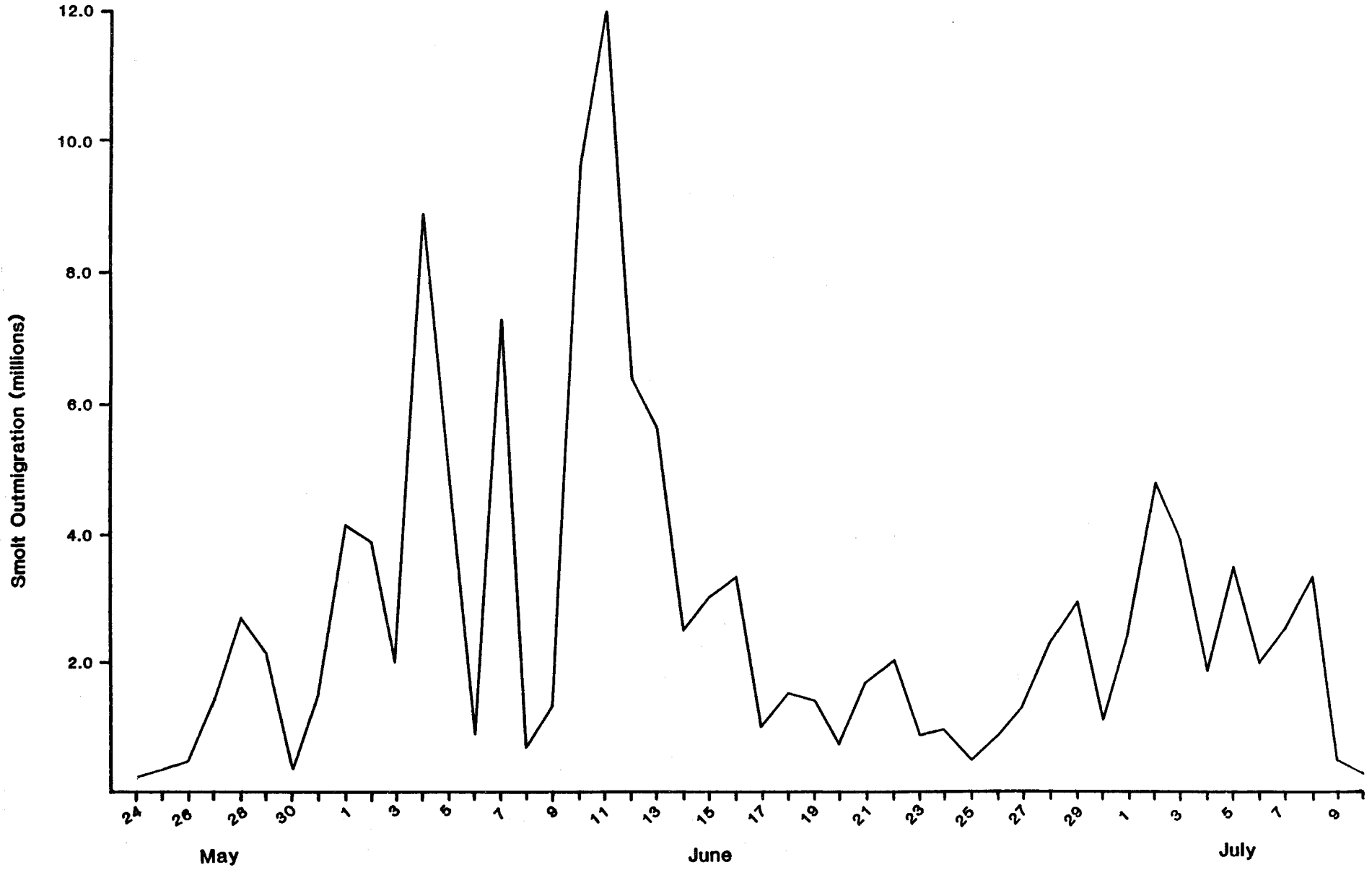

Figure 1. Naknek River smolt outmigration by date, 1982.

Table 4. Naknek River sockeye salmon escapement and smolt production by brood year, 1956-1982.

BROOD YEAR	ESCAPEMENT	ESTIMATED SMOLT PRODUCTION AGE I	AGE II	AGE III	TOTAL	AGE PROPORTION AGE I	AGE II	AGE III	SMOLT/ SPAWNER
1956	1,772,595	9,698,033	2,430,770	20,07	12,148,877	0.80	0.20	0.00	6.854
1957	634,645	10,034,717	3,118,182	0	13,152,899	0.76	0.24	0.00	20.725
1958	278,118	3,553,121	1,246,008	0	4,799,129	0.74	0.26	0.00	17.256
1959	2,231,807	4,366,639	8,461,579	134,108	12,962,326	0.34	0.65	0.01	5.808
1960	828,381	8,000,637	8,717,000	7,228	16,724,865	0.48	0.52	0.00	20.190
1961	351,078	6,049,747	4,973,098	88,951	11,111,796	0.54	0.45	0.01	31.651
1962	723,066	2,248,013	9,878,527	0	12,126,540	0.18	0.82	0.00	16.771
1963	905,358	14,741,194	6,098,025	25,399	20,864,618	0.71	0.29	0.00	23.046
1964	1,349,604	3,114,885	5,284,965	390,517	8,790,367	0.35	0.60	0.05	6.513
1965	717,798	4,096,836	10,543,954	0	14,640,790	0.28	0.72	0.00	20.397
1966	1,016,445	7,661,568	4,638,035	0	12,299,603	0.62	0.38	0.00	12.101
1967	755,640	6,907,982	1,634,657	0	8,542,639	0.81	0.19	0.00	11.305
1968	1,023,222	2,018,207	2,827,916	0	4,846,122	0.42	0.58	0.00	4.736
1969	1,331,202	8,036,148	10,274,143	27,393	18,337,684	0.44	0.56	0.00	13.775
1970	732,502	716,596	1,958,715	655	2,675,966	0.27	0.73	0.00	3.653
1971	935,754	726,042	663,279	3,675	1,392,996	0.52	0.48	0.00	1.489
1972	586,518	155,025	4,770,490	19,260	4,944,775	0.03	0.96	0.01	8.431
1973	356,676	4,413,989	1,290,408	0	5,704,397	0.77	0.23	0.00	15.993
1974	1,241,058	830,312	3,753,415	-	<4,583,737>	<0.18 >	<0.82 >	<0.00>	<3.693>
1975	2,026,686	470,470	-	-	-	-	-	-	-
1976	1,320,750	-	-	-	-	-	-	-	-
1977	1,085,856	-	-	-	-	-	-	-	-
1978	813,378	-	-	0	-	-	-	-	-
1979	925,362	-	12,889,936[1]						
1980	2,644,698	115,624,396[1]							

[1] Begin sonar estimates.

Table 5. Mean length (mm), mean weight (g), standard error, and sample size (n) for sockeye salmon by age class and sample data, Naknek River, 1982.

	AGE I					AGE II				
DATE	MEAN LENGTH	S.E.	MEAN WEIGHT	S.E.	N	MEAN LENGTH	S.E.	MEAN WEIGHT	S.E.	N
5/24	96.000	1.191	8.370	0.283	27	110.330	1.853	11.830	1.657	3
5/25	102.000	2.001	8.950	0.247	2	0.	0.	0.	0.	0
5/26	89.425	0.782	6.758	0.216	10	115.389	1.865	13.685	0.827	8
5/27	91.191	1.017	7.574	0.225	26	117,593	1.751	15.036	0.410	6
5/28	89.234	0.737	6.629	0.170	93	106.764	0.853	10.716	0.300	27
5/29	95.806	0.604	8.572	0.175	74	112.465	1.792	12.509	0.464	16
5/30	99.323	2.095	9.220	0.595	11	108.061	1.269	11.555	0.389	28
5/31	94.674	0.671	7.122	0.574	38	110.530	1.242	11.111	4.894	22
6/1	95.222	0.694	8.500	0.162	73	113.521	1.225	13.834	0.380	17
6/2	91.829	0.520	7.181	0.130	82	105.165	3.387	10.679	1.029	8
6/3	98.290	0.736	9.122	0.169	46	109.200	1.756	12,400	0.532	14
6/4	93.440	0.551	7.241	0.133	113	111.025	2.457	11,066	0.772	7
6/5	93.884	0.625	8.360	0.151	112	113.217	1.897	14,415	0.837	8
6/6	91.756	0.806	7.297	0.166	62	114.500	6.498	12.250	0.453	2
6/7	96.253	0.469	7.560	0.109	118	111.003	0.	11.396	0.	2
6/8	90.506	0.815	6.806	0.200	48	115.108	4.670	14.155	1.478	8
6/9	98.948	0.634	8.909	0.169	71	115.323	2.147	14.051	0.756	21
6/10	94.760	0.430	8.077	0.106	105	107.728	2.198	11.259	0.700	15
6/11	94.303	0.534	8.432	0.142	100	116.604	1.458	48.633	0.534	19
6/12	90.522	0.624	7.889	0.157	106	122.054	2.007	15.353	0.773	14
6/13	94.293	0.499	8.470	0.119	107	117.625	2.050	16.131	0.827	13
6/14	93.817	0.658	6.471	0.534	45	107.670	0.460	7.510	7.000	4
6/15	92.403	0.479	7.941	0.121	115	107.775	2.964	11.449	0.684	5
6/16	90.333	0.492	7.220	0.349	110	104.158	0.588	10.799	0.288	7
6/17	90.373	0.573	6.722	0.120	102	113.549	1.946	12.379	0.676	18
6/18	95.497	0.687	8.019	0.150	83	119.190	3.154	13.095	0.697	6
6/19	94.309	0.650	7.746	0.145	83	114.283	2.712	14,259	0.923	7
6/20	91.994	0.870	7.576	0.203	51	108.259	4.411	12.269	1.329	9
6/21	95.211	0.867	9.400	0.518	75	95.771	2.971	8.417	0.766	12
6/22	90.284	0.706	7.064	0.129	45	110.067	1.390	10.223	0.100	4
6/23	94.500	0.836	7.440	0.199	29	92.000	0.	7.200	0.	1
6/24	93.008	0.552	7.618	0.147	64	111.000	0.	12.400	0	1
6/25	95.070	1.366	8.200	0.373	27	106.670	4.486	11,530	1.120	3
6/26	93.379	0.717	8.586	0.189	43	112.500	0.502	14,100	0.297	2
6/28	95.354	0.702	8.209	0.171	64	114.279	4.002	12.563	2.032	3
6/29	94.502	0.542	7.794	0.133	88	105.000	11.0003	10.600	2.199	2
6/30	94.094	0.924	7.595	0.201	44	0.	0.	0.	0.	0
7/1	95.876	0.740	8.753	0.160	57	108.700	3.481	12.930	0.837	3
7/2	94.071	0.849	7.628	0.181	33	5.600	0.	7.000	0.	1
7/3	91.021	0.590	7.164	0.128	67	90.000	0.	7.700	0.	1
7/4	92.861	0.638	7.429	0.158	68	113.475	0.	14.221	0.	2
7/5	95.951	1.013	8.816	0.249	43	117.635	5.064	14.237	1.344	5
7/6	96.042	0.533	8.459	0.130	62	96.000	0.	9.200	0.	1
7/7	95.440	1.012	9.100	0.252	27	0.	0.	0.	0.	0
7/8	96.000	7.000	8.800	1.902	2	0.	0.	0.	0.	0
7/9	99.710	1.754	8.970	0.317	7	0.	0.	0.	0.	0
7/10	96.670	0.833	8.100	0.217	9	0.	0.	0.	0.	0
MEAN	93.940		7.954			100.063		14.678		

Table 6. Comparative counts from Naknek and Egegik River sonar smolt counting systems in the Naknek River, 1982.

DATE	NAKNEK	EGEGIK	NAK:EGE	NO. OF HOURS
6/30	32,361	28,192	1.15	24
7/01	95,394	68,492	1.39	16
7/02		--- NO DATA ---		
7/03	196,375	136,112	1.44	22
7/04	71,517	59,896	1.19	20
7/05		--- NO DATA ---		
7/06	162,489	113,811	1.43	24
7/07	23,627	11,230	2.10	13
TOTAL	581,763	417,733	1.39	119

Naknek counts expressed as a linear function of Egegik counts:

$$Y = a + bx$$

where: $a = 3146.31$

$b = 0.69$

$r^2 = 0.99$

DISCUSSION

Outmigration Estimation

Sockeye salmon smolt studies have been conducted on the Naknek River in various forms for many years. This was the first attempt at enumerating outmigrant smolt with sonar equipment designed specifically for the Naknek River, therefore, no attempt to compare outmigration estimates from past years should be made. Age, length, and weight data however, were collected in the same manner as in previous studies and those comparisons are possible. Appendix Table 2 clearly shows that both Age I and Age II smolt were relatively small in the 1982 outmigration. This would be expected if the seemingly very large outmigration estimate is in fact accurate (Mathisen 1969).

Sonar Count Comparisons

The results of the sonar counting ability investigations, while cursory, are worthy of further consideration. There are no final explanations of how two theoretically identical counting systems could have performed so differently *in situ*. However, two possible causes have been suggested. The first is that migrating smolt were somehow able to more successfully avoid the downstream (Egegik) array, although this seems unlikely. Perhaps more plausible is the possibility that the downstream array may not have been resting in a perfectly flat plane with respect to the surface of the water. Echoes from the downstream array may therefore have been partially received by transducers in the upstream array. No formal *in situ* calibration tests were conducted upon either system though, so this question remains largely unanswered.

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Mathisen, Ole A. 1969. Growth of sockeye salmon in relation to abundance in the Kvichak District. Bristol Bay, Alaska. Fisk, Dir. Skr. Ser. HavUnders. 15:172-185.

Randall, Richard C. 1977. 1976 Kvichak River sockeye salmon smolt studies. (Ed. N. Newcome). Alaska Department of Fish and Game, Technical Data Report No. 33, pp. 1-13.

Appendix Table 1. Naknek River water temperatures (C) during smolt studies, 1967-1982.

YEAR	START	END	MINIMUM	MAXIMUM	MEAN
1967	14.4	14.4	10.6	15.0	13.0
1968	10.0	15.6	7.2	16.7	12.9
1969	6.7	12.2	6.7	13.9	11.0
1970	12.2	14.4	11.1	14.4	12.1
1971	6.1	10.0	4.4	10.0	7.2
1972	8.3	14.4	6.7	14.4	10.1
1973	6.9	15.2	6.9	15.9	11.1
1974	8.1	13.9	8.1	14.3	12.1
1975	3.9	12.9	3.5	13.2	9.0
1976	7.7	12.3	4.6	12.8	9.5
1982	6.0	11.2	5.0	14.4	8.9
Mean	8.2	15.3	6.8	11.0	10.6

Appendix Table 2. Annual percent, mean length, and mean weight of Naknek River sockeye salmon smolt by age group, 1957-1982.

YEAR OF EMIGRATION	AGE I			AGE II			AGE III		
	%	LENGTH (mm)	WT. (g)	%	LENGTH (mm)	WT. (g)	%	LENGHT (mm)	WT. (g)
1957	57.9	111.0	13.1	42.1	112.0	13.1	0.0	0.0	0.0
1958	96.4	91.0	6.9	3.6	114.0	11.3	0.0	0.0	0.0
1959	80.5	97.0	8.2	19.5	106.0	10.1	0.0	0.0	0.0
1960	53.1	99.0	8.8	46.6	109.0	11.9	0.0	0.0	0.0
1961	77.8	103.0	10.8	22.2	113.0	13.8	0.0	0.0	0.0
1962	48.6	105.0	10.4	51.4	112.0	12.5	0.0	0.0	0.0
1963	40.6	98.0	8.1	58.5	114.0	12.8	0.0	0.0	0.0
1964	31.1	97.0	7.7	68.8	110.0	11.0	0.0	0.0	0.0
1965	59.6	99.0	8.4	40.0	114.0	13.0	0.0	0.0	0.0
1966	33.8	106.0	10.6	66.2	118.0	14.2	0.0	0.0	0.0
1967	43.5	113.0	13.1	56.2	119.0	14.7	0.0	0.0	0.0
1968	41.2	99.0	8.4	56.7	108.0	11.1	0.0	0.0	0.0
1969	59.8	100.0	7.5	40.2	112.0	12.1	0.0	0.0	0.0
1970	55.3	99.6	9.0	44.7	113.7	12.1	0.0	0.0	0.0
1971	74.0	102.0	8.8	26.0	120.0	13.5	0.0	0.0	0.0
1972	6.5	98.0	9.1	93.5	110.0	11.9	0.0	0.0	0.0
1973	26.8	106.4	10.7	72.2	114.3	12.9	1.0	121.9	15.2
1974	18.9	104.0	10.3	81.0	118.0	14.5	0.0	0.0	0.0
1975	48.0	97.5	8.3	51.9	110.7	12.1	0.1	108.5	11.5
1976	38.8	91.3	7.2	60.3	107.1	13.4	0.9	131.0	22.2
1977	11.1	91.6	7.2	88.9	112.9	11.9	0.0	0.0	0.0
1978	46.9	95.7	8.3	53.1	105.0	11.0	0.0	0.0	0.0
1979	---	---	---	---	---	---	---	---	---
1980	---	---	---	---	---	---	---	---	---
1981	---	---	---	---	---	---	---	---	---
1982	90.6	93.9	8.2	9.4	100.1	14.7	0.0	0.0	0.0
MEAN	47.4	99.9	9.1	50.1	111.9	12.6	0.1	120.5	16.3

1982 EGEGIK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

The Egegik River sockeye salmon smolt project was a cooperative venture between the United States Fish and Wildlife Service and the Alaska Department of Fish and Game in 1982. The Egegik River - Becharof Lake system is a major sockeye salmon producing system for which very little historic smolt data exists. This data is necessary to more accurately forecast returns of adults and to assist in establishing optimum escapement levels.

Specific objectives of the 1982 project were to make an outmigration estimate of sockeye salmon smolt along with run timing, physical attributes of smolt, and climatological and hydrological features.

METHODS AND MATERIALS

The arrays were located approximately 4 km below the outlet of Becharof Lake (Figure 1). The sonar counting system consisted of three 3.05 m long arrays placed at 40, 55, and 70 m from the west shore (Figure 2). Each array was independently anchored and housed 10 upward - facing transducers, and sonified roughly 3.35 m of river width. Installation of the sonar arrays closely followed the procedure described by Randall (1977).

River Velocity Adjustment

The Egegik River is subject to tidal influences and, therefore, river velocity fluctuates according to the tidal cycle. The counting rate of the smolt counter depends on the assumed residence time of smolt in the transducer beam which in turn depends on river velocity. The counter was adjusted continuously for change in river velocity as determined by a flow meter positioned 0.61 m below the surface and directly behind the inshore array.

River velocity at the center and offshore arrays averaged 1.48 and 1.68 times that of the inshore array, respectively. The counts from the center and offshore array were corrected for differences in river velocity by multiplying raw counts by 1.48 and 1.68, respectively.

The smolt biomass counter was monitored by technicians 24 hours a day. The counter was adjusted for river velocity and depth immediately every half hour. Total hourly counts were derived for each array by subtracting false counts

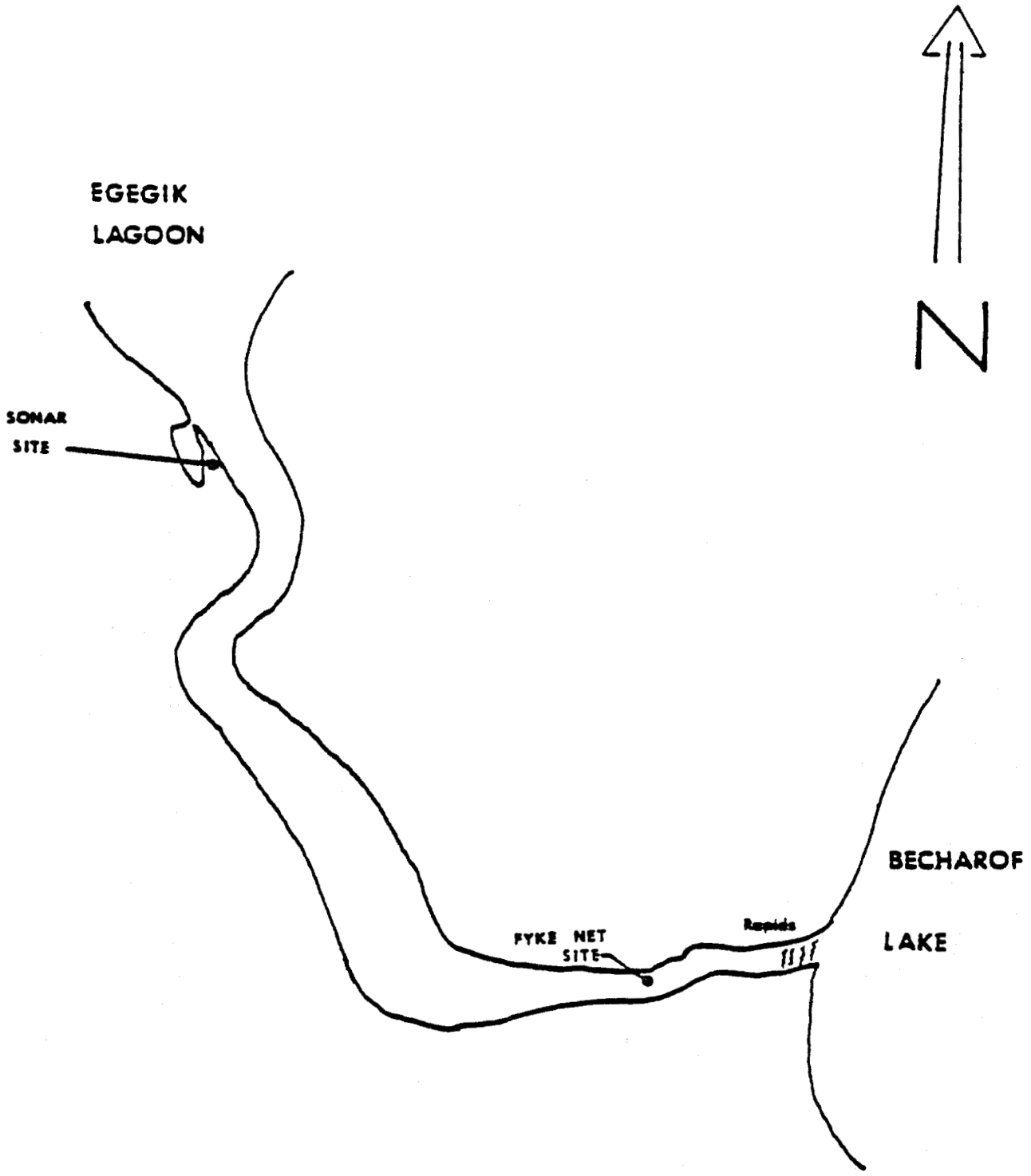

Figure 1. Egegik smolt sonar and fyke net sites, 1982.

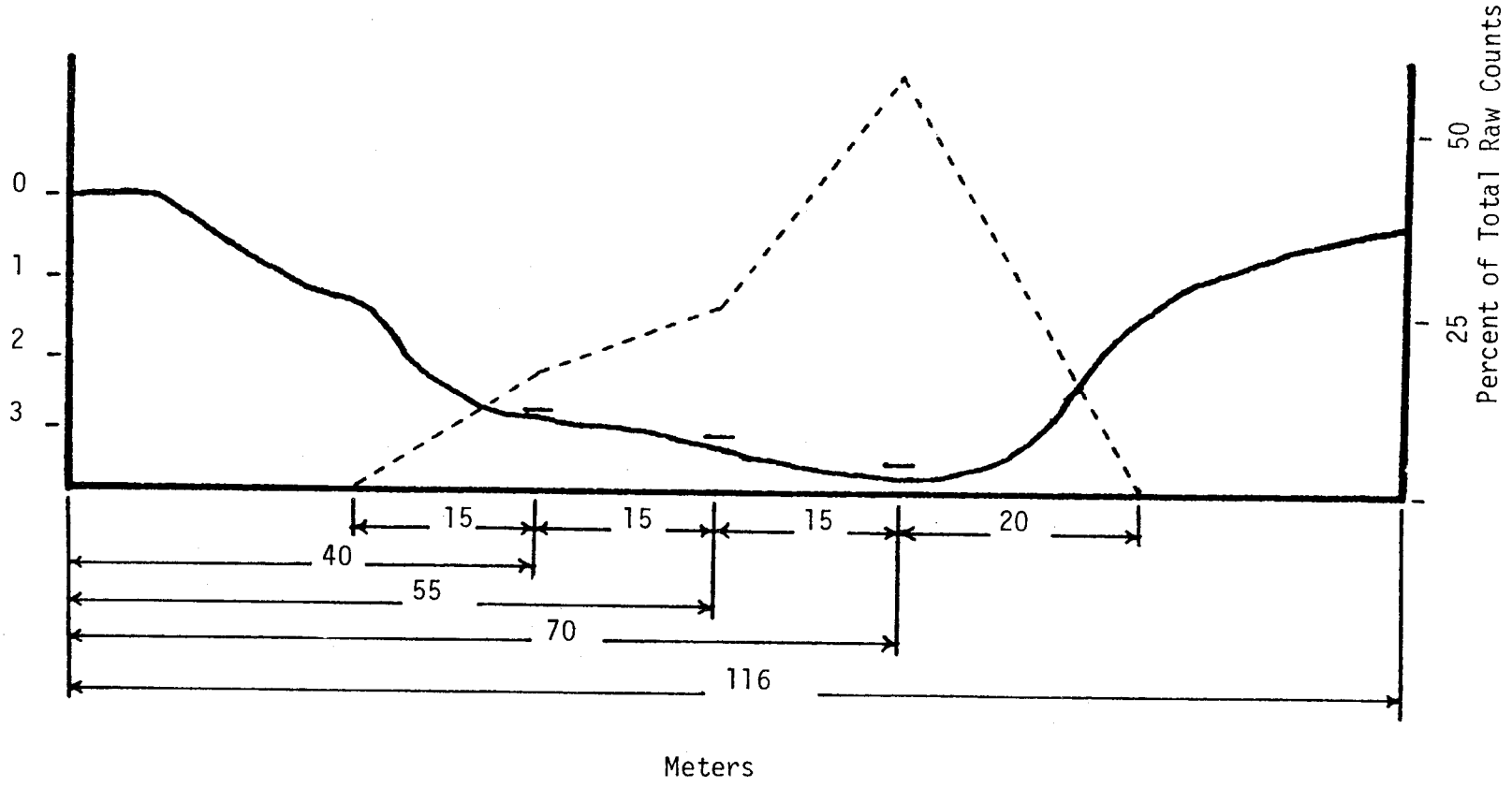

Figure 2. River bottom profile at sonar site, location of arrays, and estimated lateral smolt distribution, Egegik River, 1982.

and linearly interpolating for missed time. Hourly counts were then totaled for each array at the end of the smolting day and multiplied by a velocity correction factor. The counts for each array were then expanded to reflect the estimated number of smolt migrating in sections of the river not covered by arrays. Lateral smolt distribution was determined by side scan sonar, although counting conditions were poor because of low smolt densities.

The majority of the run was determined to have occurred between 25 m and 90 m from the standardized point (Figure 2). Daily counts were then expanded based on the inverse of the estimated proportion of the river width sampled where smolts occurred (i.e., river between 25 and 90 m of the reference point). These expansion factors were 5.28, 5.25, and 4.91 for the inshore, center, and offshore arrays, respectively.

The smolt counter functioned as a biomass counter and was designed to count once for the biomass equivalent of five smolt passing over the arrays. Therefore the daily counts were multiplied by 5 as the final adjustment in estimating the numbers of outmigrating smolt.

Age-Weight-Length Sampling

Samples from fyke net catches were used to apportion sonar counts for age class and species. A standard 1.2 x 2.1 m fyke net was fished in 1 m of water approximately 3 km upstream from the sonar site. An effort was made to collect 30 smolt twice daily at 1200 and 2300 hours daily.

All smolt captured were identified according to species. Salmon smolt were sampled for age, weight, and length. All sockeye samples for the day were placed in a single group to derive the estimated age composition for the days outmigration.

Climatological and Hydrological Observations

Basic weather and river conditions were recorded at the sonar site. Subjective observations were made of sky conditions, wind velocity, and river turbidity while air and water temperature along with precipitation were measured daily at 0800 hours and 2000 hours. A Ryan thermograph was placed near the inshore array and was used for water temperature measurements.

RESULTS

Climatological and Hydrological Observations

Weather and river conditions were recorded at the sonar site from 15 May through 16 June (Table 1). Shore ice was present on Lake Becharof and in the Egegik River upon arrival at the site and continued to flow down the river until 23 May. The ice hampered counting but posed no real threat to the sonar gear. The mean air and water temperatures during the period 15 May to 16 June were 10.3°C and 2.9°C, respectively. The mean water temperature during the peak outmigration period (28 May to 2 June) was 3.5°C.

Table 1. Climatological and stream observations, Egegik River, 15 May - 16 June, 1982.

Date	Sky 0800	Sky 2000	Wind (MPH) Direction 0800	Wind (MPH) Direction 2000	Air Temp C Max.	Air Temp C Min.	Water Temp C 0800	Water Temp C 2000	Precipitation (cm) 24 Hours	Turbidity 0800
5/15	1	2	calm	5 SE				2.0	0	1
5/16	1	3	5 SE	25 SE			0.0	1.5	0	1
5/17	4	3	10 SE	15 SE			0.0	1.5	T	1
5/18	2	4	calm	calm			0.0	1.5	0	1
5/19	3	4	calm	calm			0.5	2.0	0	1
5/20	3	4	calm	5 SE			0.5	1.5		
5/21	4	4	calm	5 SE	13	2	0.5	2.5	0.15	1
5/22	5	3	calm	5 SW	12	5	0.5	2.5	T	1
5/23	3	3	calm	25 SE	15	8	1.5	2.0	T	1
5/24	4	3	5 SE	25 SE	4	3	1.5	2.0	T	1
5/25	1	4	15 SE	5 SE	2	2	1.0	2.0	T	1
5/26	4	4	30 SE	50 SE			1.5	3.5	0	1
5/27	3	4	45 SE	35 SE	15	10	2.0	4.5	0	1
5/28	4	4	15 SE	20 SE			3.0	5.0	0	1
5/29	4	4	20 SE	20 SE	15	10	2.5	3.0	0.31	1
5/30	5	4	15 SE	10 SE	20	11	2.5	4.0	0	1
5/31	4	2	calm	5 SW	17	2	2.5	4.0	0	1
6/1	3	3	20 SE	25 SE	15	10	3.0	4.5	0	1
6/2	4	2	15 SE	10 SW			3.0	5.0	0	1
6/3	1	1	calm	40 SW	14	10	3.5	4.5	0	1
6/4	3	4	30 SE	20 SE	15	4	3.0	4.5	0.10	1
6/5	4	4	35 SE	15 SE	15	2	4.0	3.0	0.47	1
6/6	3	2	5 NW	5 SW	13	8	2.0	4.5	0	1
6/7	5	3	calm	5 NW	29	16	3.5	4.5	0	1
6/8	3	3	5 SE	5 SE	11	0	3.0	4.0	0	1
6/9	4	4	5 SE	15 SE	15	5	3.5	4.0	0.03	1
6/10	4	4	10 SE	25 SE	13	9	4.0	4.0	0.06	1
6/11	3	4	20 SE	15 SE	15	10	3.0	4.0	1.00	1
6/12	3	2	15 SE	15 SE	10	4	3.0	5.0	0.20	1
6/13	3	4	25 SE	15 E	15	5	3.5	4.0	0	1
6/14	3	3	calm	5 SE	17	0	3.5	5.0	0	1
6/15	4	3	calm	calm	21	10	4.5	5.5	0.80	1
6/16	3	0	calm				5.0			
Seasonal Mean					10.3		2.9			

Sky Codes: 1 - Clear sky, cloud covering not more than 1/10 of sky.
2 - Cloud covering not more than 1/2 of sky.
3 - Cloud covering more than 1/2 of sky.
4 - Completely overcast.
5 - Fog.

Turbidity Codes: 1 - Clear
2 - Light turbidity

Outmigration Estimate

Some difficulties were encountered with the new smolt sonar biomass counter. These problems were due to the untested nature of the counter and were corrected both in the equipment and data post-season. The counter was operated continuously from noon, 15 May until noon 16 June. There was no evidence of smolt outmigration until 27 May when sockeye salmon smolt were present (Figure 3). Coho salmon *(Oncorhynchus kisutch)* smolt began to appear in the fyke net samples on 7 June at which time species were apportioned by percentage and the daily coho percentage was subtracted from the daily outmigration estimate.

A total of 5,683,515 sonar counts was tallied during the 1982 season (Table 2). This was an overcount of 2.0 times because of a wiring error in the biomass counter. There was also a substantial overcount because of the increased size of Egegik system smolt in relation to Kvichak system smolt, the standard with which the transducers were calibrated. To compensate for this size difference, the daily sonar counts were also multiplied by 0.613. This factor was supplied by Bendix and was the result of a comparison between historical Kvichak sockeye salmon smolt size and historical Egegik sockeye salmon smolt size.

The in-season outmigration estimate was achieved by applying velocity correction factors, expanding by the inverse of the proportion of the smolt lateral distribution sampled, multiplying by a 5 smolt/count factor, and finally subtracting a percentage for coho salmon smolt. Post-season this estimate was then divided by 2.0 and multiplied by 0.613 to compensate for the wiring error and difference in smolt size. The final outmigration estimate was 60,429,515 sockeye salmon smolt (Table 3).

Age-Weight-Length

Problems arose with the fyke net sampling scheme shortly after the onset of the smolt outmigration. Samples were very difficult to obtain during the 1200 hour sample period although smolt appeared to be present in large enough numbers. To make better use of sampling effort, the 1200 hour sample was discontinued on 3 June and an additional 30 smolt were taken during the 2400 hour sample.

All samples were placed in a single group and all the daily population parameters were derived from that group. A total of 881 sockeye salmon smolt was sampled for age, weight, and length. Daily mean weights and lengths by age class are presented in Table 4. The estimated age composition of the total sockeye outmigration was 82.7% Age I, 17.1% Age II, and 0.2% Age III. The estimated mean length were 104.1 mm Age I, 130.1 mm Age II, 145.0 mm Age III. Estimated mean weights were 9.23 g Age I, 17.05 g Age II, and 23.47 g Age III. Appendix Table 1 provides the historic smolt age composition, weight, and length data available since 1939.

Coho smolt began to appear in the samples on 7 June. These were sampled (n = 53) and found to be 17% Age I, 62% Age II, and 21% Age III. Estimated mean lengths were 120.6 mm Age I, 138.9 mm Age II, and 158.5 mm Age III. Mean weights were 17.1 g Age I, 25.6 g Age II, and 35.1 g Age III. Appendix Table 2 provides a summary of the coho salmon smolt data for the past 2 years.

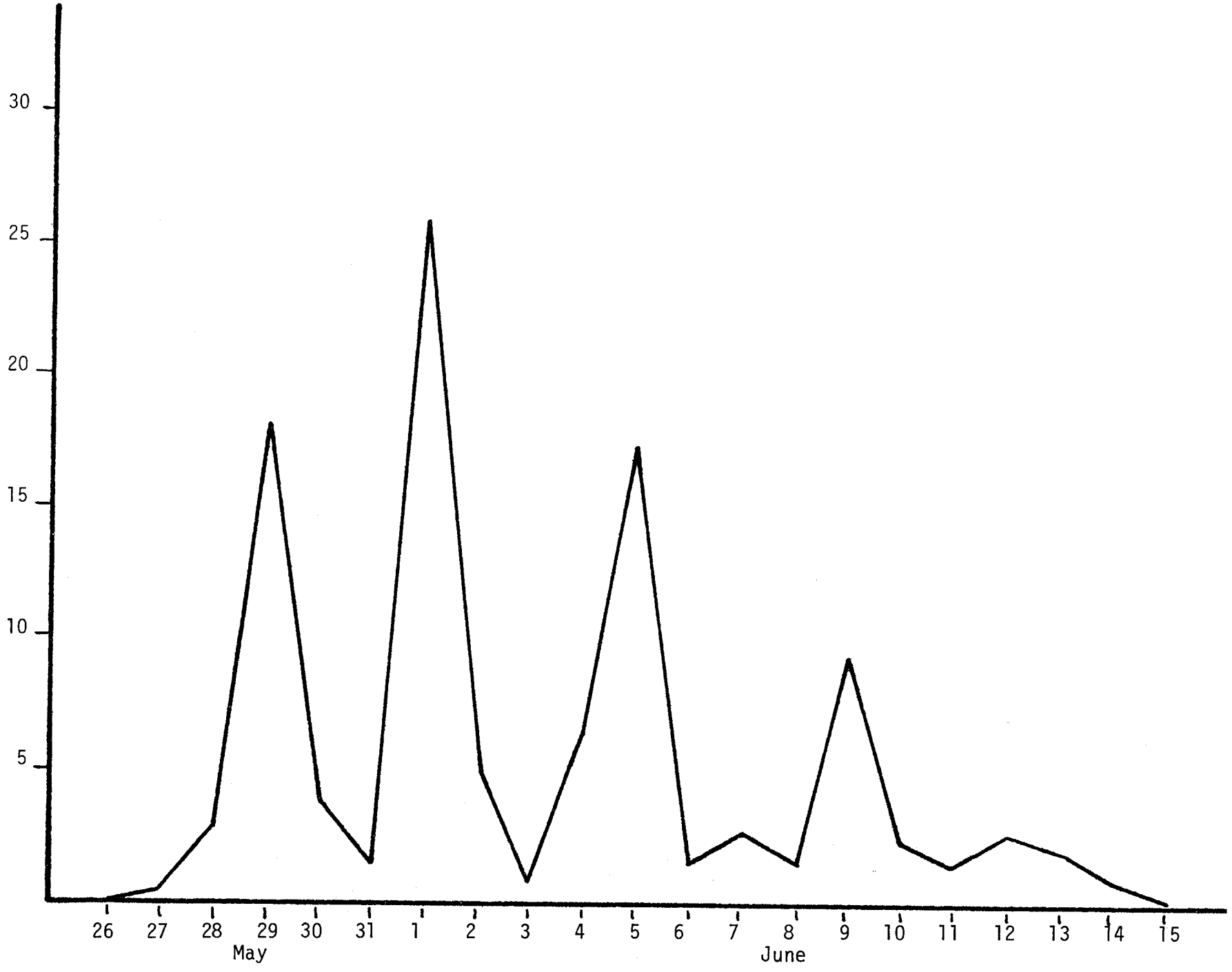

Figure 3. Percent outmigration by day, Egegik River, 1982.

Table 2. Egegik River sockeye salmon counts by array, 1982.

DATE	INSHORE	CENTER	OFFSHORE	TOTAL
5 27	1,191	5,845	18,225	25,261
5 28	39,681	89,985	68,438	198,104
5 29	36,547	537,665	625,386	1,199,598
5 30	2,236	24,342	156,295	182,873
5 31	2,829	14,175	47,799	64,803
6 1	380,538	225,396	791,652	1,397,586
6 2	21,884	21,377	134,628	177,889
6 3	12,875	8,484	13,999	35,358
6 4	30,643	108,999	203,111	342,753
6 5	2,482	37,767	516,623	556,872
6 6	53,561	23,551	17,368	94,480
6 7	17,773	45,627	82,074	145,474
6 8	14,797	16,349	46,646	77,792
6 9	78,728	64,643	335,559	478,930
6 10	56,605	37,629	45,451	139,685
6 11	83,807	112,813	37,532	234,152
6 12	40,689	60,418	49,845	150,952
6 13	6,944	20,300	80,330	107,574
6 14	4,706	14,322	36,277	55,305
6 15	6,989	6,954	4,131	18,074
TOTAL	895,505	1,476,641	3,311,369	5,683,515
% OF TOTAL	15.76	25.98	58.26	

Table 3. Daily smolt outmigration estimate by age class and species with sockeye salmon smolt accumulated total, Egegik River, 1982.

DATE	AGE I	%	AGE II	%	AGE III	%	COHO	%	SOCKEYE TOTAL	SOCKEYE ACCUM
5 27	242,254	77.92	67,674	21.77	980	.32	0	0.00	310,910	310,910
5 28	1,647,343	77.92	460,189	21.77	6,669	.32	0	0.00	2,114,201	2,425,111
5 29	10,997,348	77.92	3,072,133	21.77	44,523	.32	0	0.00	14,114,005	16,539,117
5 30	1,827,120	77.92	510,410	21.77	7,397	.32	0	0.00	2,344,928	18,884,045
5 31	624,490	77.92	174,452	21.77	2,528	.32	0	0.00	801,471	19,685,517
6 1	12,078,732	77.92	3,374,220	21.77	48,901	.32	0	0.00	15,501,854	35,187,372
6 2	1,685,445	77.92	470,832	21.77	6,823	.32	0	0.00	2,163,102	37,350,474
6 3	283,083	77.92	79,080	21.77	1,146	.32	0	0.00	363,309	37,713,784
6 4	2,969,911	73.55	997,796	24.71	11,738	.29	58,693	1.45	3,979,446	41,693,231
6 5	5,351,732	73.55	1,798,013	24.71	21,153	.29	105,765	1.45	7,170,898	48,864,130
6 6	622,835	73.55	209,253	24.71	2,461	.29	12,309	1.45	834,550	49,698,680
6 7	1,239,709	73.55	416,503	24.71	4,900	.29	24,500	1.45	1,661,112	51,359,792
6 8	655,976	73.55	220,387	24.71	2,592	.29	12,963	1.45	878,956	52,238,749
6 9	4,175,298	73.55	1,402,768	24.71	16,503	.29	82,515	1.45	5,594,570	57,833,319
6 10	1,019,830	73.55	342,630	24.71	4,030	.29	20,154	1.45	1,366,492	59,199,812
6 11	1,516,212	67.51	259,458	11.55	16,216	.72	454,052	20.22	1,791,887	60,991,699
6 12	1,059,319	67.51	181,273	11.55	11,329	.72	317,229	20.22	1,251,923	62,243,622
6 13	895,086	67.51	153,169	11.55	9,573	.72	268,047	20.22	1,057,829	63,301,452
6 14	447,479	67.51	76,574	11.55	4,785	.72	134,004	20.22	528,839	63,830,291
6 15	118,350	67.51	20,252	11.55	1,265	.72	35,441	20.22	139,869	63,970,160
TOTALS	49,457,563	77.31	14,287,075	22.33	225,522	.35				63,970,160

Table 4. Mean length (mm), mean weight (g), standard deviation (s), and sample size (n) of sockeye salmon smolt by age class and sample date, Egegik River, 1982.

	AGE I					AGE II					AGE III				
DATE	MEAN LENGTH	s	MEAN WEIGHT	s	n	MEAN LENGTH	s	MEAN WEIGHT	s	n	MEAN LENGTH	s	MEAN WEIGHT	s	n
5/27	107.65	5.48	9.82	1.48	26	135.72	7.24	18.60	2.93	32	0.	0.	0.	0.	0
5/28	103.49	3.73	9.16	1.05	49	136.00	9.17	19.98	4.23	8	146.00	0.	25.00	0.	1
5/29	106.37	4.84	9.69	1.08	27	128.00	7.62	16.55	3.01	6	0.	0.	0.	0.	0
5/30	105.73	4.36	9.39	1.32	56	129.75	5.38	16.58	2.63	4	0.	0.	0.	0.	0
5/31	104.36	3.99	10.70	1.10	22	123.29	9.55	16.46	3.29	7	0.	0.	0.	0.	0
6/ 1	101.96	2.66	8.62	0.79	26	131.50	0.71	17.45	1.48	2	0.	0.	0.	0.	0
6/ 2	105.96	6.29	9.90	1.75	24	131.33	5.72	17.75	1.58	6	0.	0.	0.	0.	0
6/ 3	103.68	4.16	8.97	1.15	28	127.33	4.04	15.77	0.80	3	0.	0.	0.	0.	0
6/ 5	105.16	4.42	9.82	1.48	50	128.13	9.05	16.76	3.30	8	0.	0.	0.	0.	0
6/ 6	102.78	2.67	8.84	0.74	27	127.50	6.07	16.36	2.32	16	0.	0.	0.	0.	0
6/ 7	103.70	3.98	8.81	1.19	30	134.18	7.93	18.55	3.21	28	147.00	0.	22.80	0.	1
6/ 8	104.57	6.26	9.06	1.72	44	131.73	6.53	18.07	2.66	15	0.	0.	0.	0.	0
6/ 9	105.17	6.06	9.29	1.57	54	128.50	9.81	16.40	3.43	4	0.	0.	0.	0.	0
6/10	103.30	4.97	8.96	1.35	47	129.42	6.16	17.23	2.94	12	0.	0.	0.	0.	0
6/11	103.83	4.45	8.43	1.76	6	129.00	4.60	15.37	1.75	6	0.	0.	0.	0.	0
6/12	103.72	3.93	8.66	1.04	43	131.78	8.48	17.31	3.00	9	143.50	2.12	22.85	3.18	2
6/13	100.65	5.12	8.19	1.19	49	139.50	4.72	19.90	2.01	6	0.	0.	0.	0.	0
6/14	101.94	5.12	8.61	1.41	50	130.75	7.68	18.18	3.59	4	0.	0.	0.	0.	0
6/15	103.22	5.00	9.14	1.47	36	127.14	5.40	15.90	2.83	7	0.	0.	0.	0.	0
SEASONAL MEAN	104.10		9.13			130.10		17.05			145.00		23.47		

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Randall, Richard C. 1977. 1976 Kvichak River sockeye salmon smolt studies. In 1976 Bristol Bay sockeye salmon smolt studies. (Ed. N. Newcome). Alaska Department of Fish and Game Technical Data Report No. 33, pp. 1-13.

Appendix Table 1. Comparative age, length (mm), and weight (g) of sockeye salmon smolt from the Egegik River.

		Age I			Age II			Age III		
Year of Seaward Migration	Sample Dates	n	Mean Length	Mean Weight	n	Mean Length	Mean Weight	n	Mean Length	Mean Weight
1939[1]	-	-	96.4	-	-	105.0	-	-	-	-
1956[1]	-	14	101.0	-	249	116.0	-	123	123.0	-
1957[1]	-	17	106.5	-	202	119.6	-	17	130.0	-
1959[1]	-	80	99.0	-	190	116.0	-	11	123.0	-
1960[1]	-	27	106.0	-	130	115.0	-	2	140.0	-
1969[1]	-	21	99.0	-	44	119.0	-	2	115.0	-
1977[2]	27-29 May	11	110.0	11.31	288	115.5	13.25	-	-	-
1978[3]	19-22 May	42	103.6	10.10	264	122.0	15.40	13	130.1	18.60
1981	15 May - 6 June	203	104.5	9.13	343	121.5	14.64	3	128.3	19.10
1982	27 May - 15 June	694	104.1	9.23	183	130.1	17.05	4	145.0	23.47

[1] Paulus, 1972.

[2] From interoffice memo dated 2 May 1978 from John H. Clark, Alaska Department of Fish and Game, Commercial Fisheries, Anchorage, Alaska.

[3] Huttunen, 1980.

Appendix Table 2. Comparative age, length (mm), and weight (g) of coho salmon smolt from the Egegik River.

		Age I			Age II			Age III	
Year of Seaward Migration	Sample Dates	n	Mean Length	Mean Weight	n	Mean Length	Mean Weight	n	Mean Length	Mean Weight
1981	30 May - 6 June				18	141.0	27.1			
1982	7 June - 15 June	9	120.6	17.1	33	138.9	25.6	11	158.5	35.1

1982 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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INTRODUCTION

An abbreviated sampling program was conducted 6-8 June 1982, to collect a sample of sockeye salmon smolts outmigrating from the Ugashik Lake system for age, weight, and length (AWL). The purpose of the study was to collect representative size data on Age I smolt progeny from the record escapement of 3.3 million sockeye to the Ugashik system in 1980.

METHODS

A fine meshed (less than 6.35 mm mesh in the bag) beach seine approximately 138 m in length was used to collect sockeye smolts. The net was set from the lake beach just north of the outlet of Lower Ugashik Lake. The sampling site was as close to the current as possible to insure that the net could be set and retrieved before being swept downstream into the Ugashik River and subsequently lost. The net was set from the south going to the north (i.e., uplake from the outlet). The following setting procedure was followed to insure a consistent amount of sampling effort: An individual held the bridal (approximately 30 m) on one end of the net from the shore. The second individual would pay the net out from shore off the bow of the skiff. The net would be held open approximately 5 minutes in a straight line approximately 45° from the shore line, then closed and retrieved as quickly as possible. If the catch was large, a subsample was taken and subsequently processed for AWL. In some cases the catch was small so that the catches from two net hauls were pooled, and subsequently processed for AWL. Catches were standardized per unit sampling effort detailed above by either dividing by the subsample proportion or by the number of hauls in the case where catches from more than one haul were pooled for the AWL sample.

RESULTS

Effective sampling was limited to hours of darkness. Several sets were made during diurnal periods with no fish being caught. On one occasion the seine was set around sockeye smolts detected by fish dimpling the surface. No fish were caught and it was concluded that fish were able to detect and avoid the net during diurnal periods. The net was very effective in capturing smolts during nocturnal periods (Table 1). Catch per effort and age composition are presented in

Table 1. Catch per set and age composition of samples of sockeye salmon smolts, Ugashik River, 1982.

Sample Number	Date	Time	Number of Fish Sampled For AWL	Proportion of Catch Sampled For AWL	Estimated Catch Per Set	Age Composition (%)		
						Age I	Age II	Age III
1	6/06	2345	148	0.50	296	41.9	57.4	0.7
2	6/07	0300	28	2.00[1]	14	96.4	3.6	0.0
3	6/07	2345	194	0.25	776	98.4	1.6	0.0
4	6/08	0110	82	1.00	82	90.2	9.8	0.0
5	6/08	0220	60	2.00[1]	30	98.3	1.7	0.0
Mean[2]					239.6	83.9	15.9	0.2

[1] Catch pooled from two hauls.

[2] Mean age composition was taken to be mean sample age composition weighted by the estimated catch per set.

(Table 1). Mean length and weight by age are presented in Table 2. The historical record of smolt size given in Parker (1974) was updated to include results from the 1975 smolt study (Krasnowski 1976) and results from the present study (Table 3).

Table 2. Mean length (mm), mean weight (g), standard deviation (s), and sample size (n) of sockeye salmon smolt by age class and sample date, Ugashik River, 1982.

	Age I					Age II					Age III				
Date	Mean Length	S	Mean Weight	S	n	Mean Length	S	Mean Weight	S	n	Mean Length	S	Mean Weight	S	n
6/06	90.32	3.95	6.77	0.80	60	113.35	7.02	13.00	2.30	85	138.0	0	22.50	0	1
6/07	87.07	4.07	6.11	0.90	84	115.33	11.59	13.10	4.16	3	0	0	0	0	0
6/08	88.07	4.65	6.21	0.90	96	104.50	12.77	11.08	3.61	4	0	0	0	0	0
Seasonal Mean	88.28		6.32			113.03		13.00			138.0		22.50		

Table 3. Average length and weight of Ugashik River sockeye salmon smolts by freshwater age group, 1958-1982[1].

Year of Seaward Migration	Age I		Age II	
	Length	Weight	Length	Weight
1958	93.0	6.4	112.0	11.7
1959	90.0	6.1	120.0	13.5
1960	90.0	6.6	108.0	11.0
1961	90.0	6.7	112.0	12.2
1962	88.0	6.1	112.0	12.3
1963	89.8	6.1	104.3	9.6
1964	92.2	6.9	118.3	12.7
1965	93.7	6.9	114.1	12.5
1967	87.5	6.0	113.1	12.2
1968	92.8	6.5	112.6	10.7
1969	97.4	7.5	121.2	14.5
1970	97.0	7.7	124.8	15.9
1972[2]	80.8	5.0	111.5	11.2
1973[3]	93.1	7.2	112.9	11.9
1975[4]	95.8	6.6	115.7	13.0
1982[5]	88.3	6.3	113.0	13.0

[1] 1958-1968 weighted by index catch; 1969-1982 weighted by random catch.

[2] Age III smolt averaged 129.0 mm and 14.3 grams.

[3] Age III smolt averaged 131.5 mm and 20.1 grams.

[4] Age III smolt averaged 125.0 mm and 16.7 grams.

[5] Age III smolt averaged 138.0 mm and 22.5 grams.

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1982 WOOD RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

Annual sockeye salmon smolt migrations out of the Wood River Lakes system range between 20 and 100 million fish over about a 90-day period (approximately 1 June - 30 August) each summer. Reliable estimates of the number of smolts leaving the system are required for forecasting future adult returns and studying optimum escapement to the spawning grounds.

A program to enumerate smolt by sonar was initiated in 1975 because various index programs operated prior to that time proved to be of limited value in forecasting future runs. The sonar project has continued through 1982 with the major objectives being: (1) estimating numbers of outmigrating smolt, and (2) determining the qualitative aspects of the smolt run (age composition, mean length, weight, and incidence of the parasite *(Triaenophorus crassus)*.

METHODS AND MATERIALS

Sonar Arrays

The same four transducer arrays and electronic control unit used since 1976 (Krasnowski 1976; 1977) were used again in 1982. The system consists of 40 transducers mounted in four ladder-like arrays, each monitored separately on the river bottom. The 10 transducer cables from each array are taped together and the entire bundle is secured to the river bank with a safety line. The four cable bundles are connected to the electronic counting unit which is powered by a 12-volt battery. The counter is kept in a wall tent where technicians control and monitor the system. Placement of the gear has been in the same location in the river each year since 1975.

Installation and operation of the gear was similar to methods used in 1979 and 1980 (Bucher 1980; 1981). The arrays were positioned in the river so that distances from the north bank of Arrays I, II, III, and IV were: 24.7, 44.5, 59.6, and 68.7 m, respectively.

Array III was placed in the river on 3 June, but the other arrays were not deployed until 6 June so as not to risk damage by lake ice. Due to high water and velocities exceeding 7.0 feet per second, the equipment was difficult to deploy and resulted in Arrays III and IV being slightly closer to the north bank by 4-5 m than past years.

Full-time counting began on 6 June and continued through 9 August. The sonar data collection procedures were consistent with those used in past years (Bucher 1980), but the sampling design was changed to a full 24-hour operation instead of 75 hours per 5-day period as was the previous schedule. Array I was designated as the index array and operated continuously throughout the season. The other three arrays were operated in a random sequence of 15-minute intervals within each hour, and these 15-minute counts were expanded to yield hourly counts for each array.

Adjustment of Sonar Counts

Wood River is affected by tidal fluctuations throughout its entire length. As a result, the river velocity fluctuates continually with the flood and ebb of the tide. Because counts registered on the sonar are a function of river velocity, compensation must be made for the tidal fluctuations. To compensate for changes in river velocity, a technique was developed in 1981 in which a flowmeter was permanently installed in the river channel behind Array I. The flowmeter, equipped with a remote digital readout, allowed technicians to simultaneously monitor river velocity while operating the sonar counter. As changes in river velocity occurred, the technician changed the velocity setting on the counter. This technique has eliminated the need to estimate velocities and correct the sonar counts after the season and was used again this year to adjust for changes in river velocity.

It was still necessary to determine the ratio of the river velocity behind each array to the velocity behind Array I. This array ratio factor (ARF) was derived by measuring river velocity behind Array II, III, and IV at a time not influenced by tides on or near the third day of each sample period. The actual ARF, computed once each sampling period, was the ratio of velocities behind a given array to the average velocity behind Array I, which was continuously measured by the flowmeter. Sonar counts for Arrays II, III, and IV were adjusted by the ARF to account for differences in velocity across the river.

During periods when the flowmeter was not properly functioning, the sonar counter was operated at one velocity setting. Periods off tidal influences were taken into account by applying velocity factors to the raw sonar counts to yield corrected counts (Bucher 1980). Appendix Table 1 provides a summary of the river velocity data used to adjust counts throughout the season.

After the sonar counts were adjusted for the actual river velocity, they were expanded for those sections of river not covered by sonar. The individual expansion factors, which were a function of distance between the individual arrays, were as follows: Array I - 6.386, Array II - 5.206, Array III - 3.615, and Array IV - 7.705.

After expansion, the counts were summed to yield a daily total expanded count. Since the sonar system is a biomass counter designed to register one count for the biomass equivalent of five smolt, the daily total expanded count was multiplied by five to estimate the actual daily smolt count.

Age-Weight-Length Sampling

Smolt samples were collected for age-weight-length analysis during each 5-day sampling period. Samples were obtained by fyke net, which is the preferred method for collecting samples in the Wood River (Bucher 1980). Sampling goals were set at 300 smolt per 5-day period or 60 fish per day. Fork length measurements, weights, and scale samples were taken from the samples and all smolt were externally examined for presence of the parasite *Triaenophorus crassus*.

RESULTS

Climatological and Hydrological Observations

Daily water temperatures and lake level measurements recorded at the sonar site during the smolt outmigration are presented in Table 1. Maximum and minimum seasonal water temperatures were 12.0°C (7 August) and 2.2°C (27 May), respectively. Mean lake depth recorded at the ADF&G camp was 1.17 m. A comparison of water temperatures and mean lake depth measurements for the years 1975-1982 is presented in Appendix Table 2.

Outmigration Estimates

The sonar counter was operated for 12 five-day periods for a total of 60 days. The daily raw and expanded sonar counts for 1982 can be found in Appendix Table 3. A total of 1,284,997 raw counts was enumerated. Of this total, 38% were recorded by Array I, 31% by Array II, 16% by Array III, and 15% by Array IV. This seasonal distribution of smolt across the river is shown relative to the past 8 years in Appendix Table 4. Expansion of the raw counts yielded an estimated total outmigration of 37,061,837 smolt. Table 2 lists the estimated smolt outmigration by age class and sample period. The estimated daily total outmigration is illustrated in Figure 1.

Age-Weight-Length

A total of 3,451 smolt was measured to determine mean length and age. Age composition estimates and mean lengths by sample period derived from fyke net sampling are given in Table 3. Seasonal mean lengths of Age I and Age II smolt were 78.8 mm and 98.1 mm, respectively. Age I smolt comprised 87.3% of the outmigration; Age II smolt comprised 12.7%, the majority of which emigrated during late June. A comparison of the mean length of smolt by year and age class for the years 1951-1982 is presented in Table 4. Mean weights for the 1982 season are also given by sample period in Table 3. Mean weight of Age I smolt was 4.7 g while that of Age II smolt was 8.4 g. Mean weight data by age class are available since 1977 and are presented in Appendix Table 5. Age composition and mean length and weight of the total outmigration was weighted by the outmigration estimate for each sample period.

Table 5 lists the estimated percentage of sockeye smolt infected by the cestode *Triaenophorus crassus*. Overall, 10.0% of the Age I smolt and 21.2% of the Age II smolt were estimated to be infected by the parasite.

Table 1. Water temperatures and lake depths recorded at ADF&G cabin, Wood River, 1982.

Date	Water Temp. (°C)	Lake Depth (m)	Date	Water Temp. (°C)	Lake Depth (m)
5/27	2.2	-	7/ 6	5.0	1.46
5/28	2.2	-	7/ 7	5.5	1.43
5/29	-	-	7/ 8	6.0	1.37
5/30	-	-	7/ 9	5.2	1.34
5/31	-	-	7/10	5.7	1.28
6/ 1	-	-	7/11	4.1	1.25
6/ 2	3.0	-	7/12	7.8	1.19
6/ 3	4.5	-	7/13	-	1.16
6/ 4	-	-	7/14	5.7	1.10
6/ 5	-	-	7/15	5.9	1.07
6/ 6	-	-	7/16	5.6	1.04
6/ 7	-	-	7/17	-	-
6/ 8	-	-	7/18	-	-
6/ 9	-	-	7/19	-	-
6/10	-	-	7/20	-	-
6/11	-	-	7/21	-	-
6/12	4.0	-	7/22	-	-
6/13	-	1.62	7/23	-	-
6/14	4.5	1.62	7/24	6.5	0.91
6/15	-	1.62	7/25	7.5	0.91
6/16	5.0	1.62	7/26	7.5	0.88
6/17	5.9	1.52	7/27	8.0	0.88
6/18	4.5	1.49	7/28	6.0	0.85
6/19	-	1.52	7/29	7.0	0.82
6/20	6.1	1.46	7/30	8.0	0.82
6/21	6.1	1.46	7/31	9.0	0.79
6/22	4.9	1.43	8/ 1	8.5	0.75
6/23	4.5	1.43	8/ 2	9.5	0.72
6/24	4.6	1.40	8/ 3	10.0	0.69
6/25	5.0	1.37	8/ 4	10.5	0.61
6/26	5.0	1.37	8/ 5	11.0	0.58
6/27	4.7	1.40	8/ 6	11.5	0.52
6/28	4.8	1.49	8/ 7	12.0	0.50
6/29	4.8	-	8/ 8	12.0	0.49
6/30	4.8	1.58	8/ 9	12.0	0.46
7/ 1	5.0	1.58	8/10	9.5	0.47
7/ 2	4.8	1.58			
7/ 3	5.0	1.58			
7/ 4	5.0	1.55			
7/ 5	5.5	1.52			
Mean				6.4	1.17

Table 2. Estimated smolt outmigration, by age class and sample period, Wood River, 1982.

Sample Period	Age I			Age II			Total
	n	No.	%	n	No.	%	
6/ 6-6/15	296	1,810,262	90.2	32	196,680	9.8	2,006,942
6/16-6/20	198	1,105,781	83.9	38	212,194	16.1	1,317,905
6/21-6/25	173	1,352,219	54.1	147	1,147,262	45.9	2,499,481
6/26-6/30	243	4,462,552	78.9	65	1,193,407	21.1	5,655,959
7/ 1-7/ 5	261	8,957,162	87.0	39	1,338,427	13.0	10,295,589
7/ 6-7/10	285	5,353,754	95.0	15	281,777	5.0	5,365,530
7/11-7/15	239	1,703,191	97.2	7	49,063	2.8	1,752,254
7/16-7/20	289	2,025,338	96.3	11	77,817	3.7	2,103,155
7/21-7/25	285	1,631,866	95.0	15	85,888	5.0	1,717,754
7/26-7/30	298	952,576	96.8	10	31,490	3.2	984,066
7/31-8/ 4	271	1,113,015	96.8	9	36,794	3.2	1,149,809
8/ 5-8/ 9	228	2,146,923	97.0	7	66,400	3.0	2,213,323
Total[1]	3,057	32,354,984	87.3	394	4,706,853	12.7	37,061,837

[1] Age composition of the total outmigration weighted by outmigration estimate for each sample period.

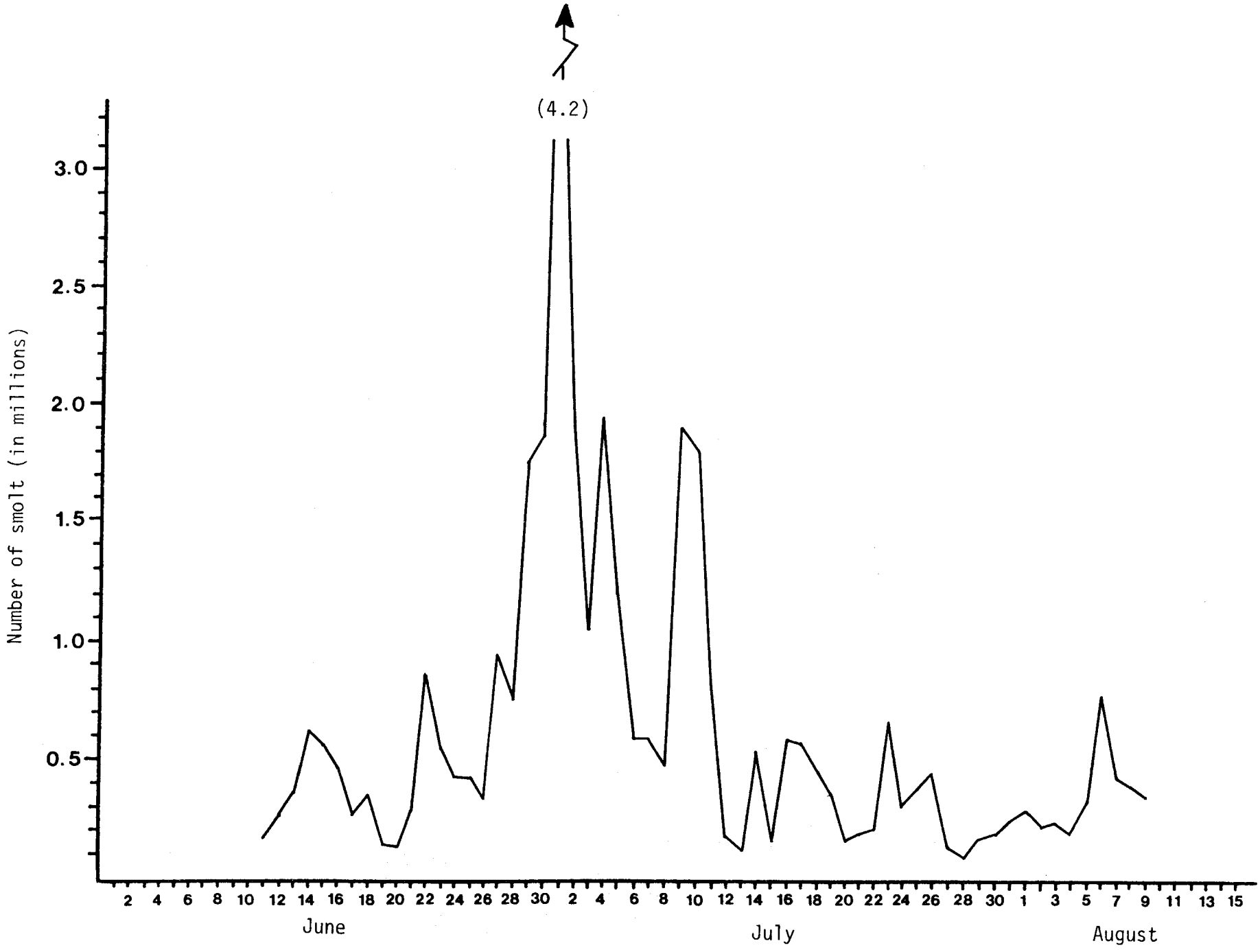

Figure 1. Estimated daily total outmigration of sockeye salmon smolt, Wood River, 1982.

Table 3. Mean length (mm), mean weight (g), variance (S^2), and sample size (n) for sockeye salmon smolt by age class and sample period, Wood River, 1982.

	Sample Period	AGE I					AGE II				
		Mean Length	S^2	Mean Weight	S^2	n	Mean Length	S^2	Mean Weight	S^2	n
1	6/ 6-6/15	72.6	82.2	3.2	1.5	296	96.2	107.0	6.8	4.7	32
2	6/16-6/20	76.2	37.5	3.7	.76	198	98.9	77.9	8.4	8.3	38
3	6/21-6/25	82.1	33.8	5.1	1.3	173	100.5	26.7	9.0	2.0	147
4	6/26-6/30	79.6	33.7	4.6	1.0	243	98.1	31.6	8.4	1.8	65
5	7/ 1-7/ 5	79.3	25.7	4.6	1.0	261	96.5	23.6	8.0	1.5	39
6	7/ 6-7/10	76.4	35.2	4.2	1.0	285	94.6	57.8	7.6	3.4	15
7	7/11-7/15	74.5	39.7	3.7	1.1	239	97.7	186.5	7.7	2.3	7
8	7/16-7/20	77.2	55.1	4.6	1.8	289	99.6	22.0	9.4	3.0	11
9	7/21-7/25	78.7	75.7	5.0	3.0	285	100.5	35.6	10.0	4.4	15
10	7/26-7/30	80.2	39.0	5.2	1.5	298	97.3	82.4	9.0	6.7	10
11	7/31-8/ 4	84.5	51.8	6.6	2.8	271	98.3	50.4	9.8	4.3	9
12	8/ 5-8/ 9	86.7	91.6	7.1	5.2	228	102.3	66.8	11.7	8.8	7
	6/ 6-8/ 9[1]	78.8		4.7		3,057	98.1		8.4		394

[1] Seasonal means were derived by weighting the mean for each sample period by the total outmigration estimate for that period (Table 2).

Table 4. Mean length of sockeye salmon smolt by year and age class, Wood River, 1951-1982[1].

Year of Seward Migration	Age I		Age II	
	Percent	Mean Length (mm)	Percent	Mean Length (mm)
1951	80.0	91	20.0	-
1952	99.0	87	1.0	-
1953	95.3	86	4.7	103
1954	95.8	87	4.2	107
1955	98.0	85	2.0	102
1956	78.4	82	21.6	95
1957	80.7	77	19.3	93
1958	65.0	82	35.0	102
1959	93.5	88	6.5	105
1960	99.4	88	0.6	114
1961	93.0	82	7.0	102
1962	86.0	80	14.0	98
1963	84.3	83	15.7	102
1964	98.8	84	1.2	104
1965	92.0	86	8.0	106
1966	94.3	77	5.7	101
1967-1974[2]	-	-	-	-
1975	(86.0)[3]	83	(14.0)[3]	98
1976	95.5	84	4.5	95
1977	82.9	71	17.1	98
1978	84.7	79	15.3	90
1979	92.2	90	7.8	100
1980	96.0	78	4.0	95
1981	66.1	88	33.9	96
1982	87.3	79	12.7	98
1951-82 Mean	88.5	83	11.5	100
1951-66 Mean	89.6	84	10.4	103
1975-82 Mean	86.3	82	13.7	96

[1] 1951-1974 Data Source: ADF&G Bristol Bay Annual Management Report, 1974. Age and length weighted by estimated outmigration for a given sample period based on a fyke net index program.

[2] Program not in operation or incomplete data.

[3] Percentage not weighted by estimated outmigration by period.

Table 5. Estimated infection by the cestode *Triaenophorus crassus* of Age I and Age II sockeye salmon smolt by sample period, Wood River, 1982.

Sample Period	Age I		Age II	
	n	% T.C.	n	% T.C.
6/ 6-6/15	296	19.6	32	31.3
6/16-6/20	198	19.2	38	28.9
6/21-6/25	173	11.6	147	29.9
6/26-6/30	243	7.8	65	20.0
7/ 1-7/ 5	261	10.3	39	17.9
7/ 6-7/10	285	9.8	15	20.0
7/11-7/15	239	14.6	7	14.3
7/16-7/20	289	8.7	11	9.1
7/21-7/25	285	8.4	15	0.0
7/26-7/30	298	7.7	10	10.0
7/31-8/ 4	271	3.9	9	0.0
8/ 5-8/ 9	228	2.1	7	0.0
6/ 6-8/ 9[1]	3,057	10.0	394	21.2

[1] The overall percentage of smolt infected by the parasite *T. crassus* was derived by weighting the percentage of infection in each sample period by the total outmigration estimate for that period (Table 2). Infection was only determined by gross external observations.

DISCUSSION

Smolt Production

The 1982 Wood River smolt run began in mid-June immediately after the ice went out of the lake. Although Array III was installed on 3 June prior to ice-out, no smolt were observed to be emigrating at that time. Beach seining in Lake Aleknagik also failed to produce smolt from 28 May - 10 June. Thus, it did not appear that significant numbers of smolt migrated prior to lake ice breakup or while ice was still drifting down Wood River. On 14 June a large smolt catch was made with the beach seine which corresponded with the first significant increase in the sonar counts (Figure 1).

Comparison of individual smolts with past years showed this year's run to be just slightly less than the long-term average length and weight. Age I smolt averaged 79 mm while Age II averaged 98 mm (Table 4).

The ratio of Age I to Age II smolts was typical in 1982 at 87% and 13%, respectively. By comparison the 1981 smolt run was comprised of nearly 34% Age II smolt, which was considerably higher than normal. The 1982 outmigration of 32.4 million Age I smolt comes from a very large escapement of 2.97 million adults in 1980. The 4.7 million Age II smolt that emigrated were produced from another large escapement of 1.71 million adults in 1979 (Table 6 and 7). Rogers (1981) states that "Escapements of this magnitude have produced poorly in the past," but that "cold weather prevailed during past years of large escapements and we are presently in a warm period." He concludes that it will be difficult to predict the returns from the 1979-1980 escapements. However, the minimal smolt outmigrations from two of the largest escapements on record (1978 and 1980) provide early evidence that, despite warmer temperatures, production from these large escapements should be limited.

The minimal number of Age I smolt emigrating this year (from the large 1980 escapement) suggests the possibility of a large holdover and another large run of Age II smolt in 1983. It is possible that this may lead to a shift in the age structure of juvenile sockeye in the Wood River lakes, where Age II smolts become the predominant age class rather than Age I. This could come about if intraspecific competition for food acts to retard growth of the younger cohort enough that they do not attain minimum size required for smoltification during their first year of lake residence. If, however, the Age II component of the 1983 run is only average, then there would be even stronger evidence to suggest that these large escapements will not produce large returns.

Marine Survival

Survival of smolt emigrating from Wood River was calculated completely for the 1973-1976 brood years, and partially for the 1977 and 1978 brood years. Table 8 shows the adult returns by brood year for Age I and Age II smolt that emigrated from Wood River for the years that the sonar project has been in operation. Comparison of the percent survival of Age II smolt indicates a dramatic change between 1974 and 1975. The 6_3 adult return in 1981 was responsible for a large portion of the very high survival (12.52%) of Age II smolt from the 1975 brood

Table 6. Summary of smolt outmigration by year and age class, Wood River, 1975-1982, in millions of smolt[1].

Year of Outmigration	Age I	Age II	Total
1975	27.95	5.90	33.85
1976	101.40	4.80	106.20
1977	60.75	12.55	73.30
1978	46.60	8.40	55.00
1979	60.84	5.13	65.97
1980	46.30	1.99	48.29
1981	64.33	33.20	97.53
1982	32.35	4.71	37.06

[1] Totally expanded sonar counts, derived by expansion factor of (5) smolt per count.

Table 7. Summary of smolt outmigration by brood year escapements, by age class, in millions of smolts and smolt production per spawner, Wood River, 1972-1980.

Brood Year	Escapement	Age I	Age II	Total	Smolt Production Per Spawner
1972	0.43	-	5.90	-	-
1973	0.33	27.95	4.80	32.75	99.24
1974	1.71	101.40	12.55	113.95	66.64
1975	1.27	60.75	8.40	69.15	54.45
1976	0.82	46.60	5.13	51.73	63.09
1977	0.56	60.84	1.99	62.83	112.19
1978	2.27	46.30	33.20	79.50	35.02
1979	1.71	64.33	4.71	69.04	40.37
1980	2.97	32.35	-	-	-

Table 8. Wood River sockeye salmon escapement, smolt production and adult returns (in millions of fish) and marine survival by brood year.

Brood Year	Escapement	Age I Smolt	2-freshwater Adult Return	Percent Survival	Age II Smolt	3-freshwater Adult Return	Percent Survival
1972[1]	0.43	-	1.352	-	5.90	.066	1.12
1973	0.33	27.95	1.342	4.80	4.80	.099	2.06
1974	1.71	101.40	4.514	4.45	12.55	.469	3.74
1975	1.27	60.75	3.486	5.74	8.40	1.052	12.52
1976	0.82	46.60	4.522	9.70	5.13	.763	14.87
1977	0.56	60.84	3.131[3]	5.15[3]	1.99	.684[2]	3.437[2]
1978	2.27	46.30	1.174[4]	2.536[4]	33.20	-	-
1979	1.71	64.33	-	-	4.71	-	-
1980	2.97	32.35	-	-	-	-	-

[1] Incomplete data.

[2] 5_3 only.

[3] 3_2, 4_2, and 5_2 only.

[4] 3_2 and 4_2 only.

year. This was a nearly three-fold increase from the 1974 survival rate of 3.74%. Survival of Age II smolt from the 1976 brood year was calculated to be even higher at 14.87%.

The Age I component from the 1976 brood also experienced high survival at a rate of 9.7%. This is almost twice the survival of the three preceding brood year escapements as being near or slightly above the recent historical optimum. The 1977 brood year escapement was 560,000 which was slightly under the optimum, but survival of Age I smolt from this escapement (with the 6_2 adults still to return in 1983) is back down to 5.15%. Furthermore, preliminary returns from the large 1978 escapement indicate only average survival, at least for the 3_2 and 4_2 age classes. Thus, it appears that although Wood River stocks achieved some extremely high marine survival of the 1975 and 1976 broods, this production is not being sustained.

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Appendix Table 1. Standard velocity factors and array ratio factors by sample period and array, Wood River sonar site, 1982.

Sample Period	Standard Velocity Factor (Index)	Array Ratio Factor		
	I	II	III	IV
6/ 6-6/15	1.00	1.194	1.032	1.226
6/16-6/20	1.00	1.066	1.125	1.102
6/21-6/25	1.00	1.066	1.125	1.102
6/26-6/30	1.00	1.046	1.109	1.069
7/ 1-7/ 5	1.00	1.086	1.123	1.089
7/ 6-7/10	1.00	1.108	1.138	1.165
7/11-7/15	1.00	1.044	1.099	1.140
7/16-7/20	1.00	1.078	1.158	1.167
7/21-7/25	1.00	1.083	1.103	1.084
7/26-7/30	1.00	1.125	1.148	1.150
7/31-8/ 4	1.00	1.154	1.162	1.186
8/ 5-8/ 9	1.00	1.111	1.119	1.174

Appendix Table 2. Mean water temperature and lake depth, Wood River sonar site, 1975-1982.

Year	Project Dates	Temperature (°C)			Depth (m)	
		Minimum	Maximum	Mean	Mean	Range
1975	5/29 - 7/19	2.0	9.5	5.0	0.368	.567 - (-) .238
1976	6/ 9 - 8/ 7	2.0	14.0	8.0	0.570	1.067 - .244
1977	6/ 9 - 8/ 8	4.5	15.5	9.0	1.521	-
1978	5/28 - 8/ 9	5.0	16.0	9.0	0.817	.976 - .366
1979	5/30 - 8/ 2	4.5	16.0	9.0	0.933	1.457 - .329
1980	5/30 - 8/15	4.5	18.0	9.0	1.067	1.646 - .335
1981	5/27 - 8/13	5.4	17.5	11.4	0.545	1.207 - .034
1982	5/27 - 8/10	2.2	12.0	6.4	1.168	1.620 - .460

Appendix Table 3. Wood River sockeye salmon smolt outmigration estimate, by day and by array, 1982.

	DAILY RAW COUNTS				DAILY EXPANDED COUNTS				DAILY EXPANDED TOTAL
	ARRAY				ARRAY				
MO DAY	1	2	3	4	1	2	3	4	(EXPANDED COUNTS X 5)
6 11	2512	2222	976	384	16039	11568	3528	2959	170469
6 12	2406	5119	2061	1041	15362	26650	7451	8021	287416
6 13	5807	5107	2196	746	37078	26587	7939	5748	386756
6 14	11209	6527	2720	895	71569	33980	9833	6896	611389
6 15	9385	4996	2748	1858	59923	26009	9934	14316	550912
FIVE DAY TOTAL	31319	23971	10701	4924	199972	124793	38684	37939	2006942
UP TO DATE TOTAL	31319	23971	10701	4924	199972	124793	38684	37939	2006942
6 16	8180	3369	1396	2239	52229	17539	5047	17251	460332
6 17	4671	2411	1329	660	29824	12552	4804	5085	261328
6 18	4129	4716	1901	1338	26364	24551	6872	10309	340483
6 19	1413	1505	1087	674	9022	7835	3930	5193	129899
6 20	1249	1732	937	624	7975	9017	3387	4808	125934
FIVE DAY TOTAL	19642	13733	6650	5535	125414	71494	24040	42647	1317975
UP TO DATE TOTAL	50961	37704	17351	10459	325386	196287	62724	80587	3324917
6 21	5802	2081	1154	804	37046	10834	4172	6195	291230
6 22	11827	16462	1217	533	75515	85701	4399	4107	848614
6 23	6394	8294	2413	1706	40826	43179	8723	13145	529360
6 24	3808	8302	2466	998	24314	43220	8915	7690	420692
6 25	1883	8681	4597	1049	12023	45193	16618	8083	409585
FIVE DAY TOTAL	29714	43820	11847	5090	189724	228127	42827	39218	2499481
UP TO DATE TOTAL	80675	81524	29198	15549	515110	424414	105551	119805	5824398
6 26	1340	7536	2886	918	8556	39232	10433	7073	326472
6 27	4702	11096	12253	6989	30022	57766	44295	53850	929664
6 28	12123	7204	3676	3430	77405	37504	13289	26428	773131
6 29	28253	21951	6117	4314	180395	114277	22113	33239	1750123
6 30	11489	38856	14323	6216	73357	202284	51778	47894	1876568
FIVE DAY TOTAL	57907	86643	39255	21867	369736	451063	141907	168485	5655959
UP TO DATE TOTAL	138582	168167	68453	37416	884846	875477	247458	288290	11480357

-Continued-

Appendix Table 3. Wood River sockeye salmon smolt outmigration estimate, by day and by array, 1982 (continued).

MO	DAY	DAILY RAW COUNTS ARRAY 1	2	3	4	DAILY EXPANDED COUNTS ARRAY 1	2	3	4	DAILY EXPANDED TOTAL (EXPANDED COUNTS X 5)
7	1	106610	20120	4773	4406	680705	104745	17254	33948	4183261
7	2	22965	17924	12793	12375	146632	93312	46247	95349	1907700
7	3	15070	9495	3859	6728	96222	49431	13950	51839	1057212
7	4	24028	16738	6423	16167	153419	87138	23219	124567	1941713
7	5	7411	13191	10396	11365	47319	68672	37582	87567	1205702
FIVE DAY TOTAL		176084	77468	38244	51041	1124296	403298	138252	393271	10295589
UP TO DATE TOTAL		314666	245635	106697	88457	2009142	1278776	385710	681561	21775946
7	6	2659	7299	5134	5799	16978	37999	18559	44681	591085
7	7	7788	5663	6192	2195	49726	29482	22384	16912	592523
7	8	2868	4113	2610	6349	18312	21412	9435	48919	490393
7	9	34448	14248	5850	8144	219950	74175	21148	62750	1890114
7	10	28417	20721	8094	5413	181443	107874	29260	41707	1801415
FIVE DAY TOTAL		76180	52044	27880	27900	486409	270941	100786	214970	5365530
UP TO DATE TOTAL		390846	297679	134577	116357	2495552	1549717	486496	896531	27141476
7	11	8877	10865	5229	3745	56680	56563	18903	28855	805004
7	12	792	1700	1165	1992	5057	8850	4211	15348	167335
7	13	668	927	707	1233	4265	4826	2556	9500	105736
7	14	8384	4879	2214	2148	53532	25400	8004	16550	517429
7	15	831	960	1817	1879	5306	4998	6568	14478	156749
FIVE DAY TOTAL		19552	19331	11132	10997	124840	100637	40242	84732	1752254
UP TO DATE TOTAL		410398	317010	145709	127354	2620391	1650354	526738	981263	28893730
7	16	2895	7056	6056	5329	18485	36734	21892	41060	590852
7	17	4501	8412	3322	3250	28739	43793	12009	25041	547910
7	18	3943	5691	3279	2936	25176	29627	11854	22622	446394
7	19	2508	3629	4031	2915	16014	18893	14572	22460	359691
7	20	1114	994	1998	1577	7113	5175	7223	12151	158306
FIVE DAY TOTAL		14961	25782	18686	16007	95526	134221	67550	123334	2103155
UP TO DATE TOTAL		425359	342792	164395	143361	2715917	1784575	594288	1104597	30996884

-Continued-

Appendix Table 3. Wood River sockeye salmon smolt outmigration estimate, by day and by array, 1982 (continued).

MO	DAY	DAILY RAW COUNTS ARRAY 1	2	3	4	DAILY EXPANDED COUNTS ARRAY 1	2	3	4	DAILY EXPANDED TOTAL (EXPANDED COUNTS X 5)
7	21	1283	1769	1580	1560	8192	9209	5712	12020	175664
7	22	2032	1641	1633	1544	12974	8543	5903	11897	196586
7	23	10108	6906	2659	3009	64540	35953	9612	23184	666444
7	24	2470	3418	2459	2203	15771	17794	8889	16974	297142
7	25	2698	2537	2075	4990	17227	13208	7501	38448	381917
FIVE DAY TOTAL		18591	16271	10406	13306	118704	84707	37618	102523	1717754
UP TO DATE TOTAL		443950	359063	174801	156667	2834621	1869282	631906	1207119	32714638
7	26	3008	3216	3334	5001	19206	16742	12052	38533	432668
7	27	704	531	538	1793	4495	2764	1945	13815	115097
7	28	473	856	787	1019	3020	4456	2845	7851	90864
7	29	1653	1166	1191	1636	10554	6070	4305	12605	167677
7	30	1334	1735	1058	1840	8518	9032	3825	14177	177759
FIVE DAY TOTAL		7172	7504	6908	11289	45793	39066	24972	86982	984066
UP TO DATE TOTAL		451122	366567	181709	167956	2880414	1908348	656878	1294101	33698704
7	31	2104	2698	1481	1754	13434	14046	5354	13515	231741
8	1	2918	3565	1649	2127	18631	18559	5961	16389	297702
8	2	2754	2218	960	1066	17584	11547	3470	8214	204076
8	3	2854	1121	1883	1849	18223	5836	6807	14247	225562
8	4	1738	2684	1475	1005	11097	13973	5332	7744	190728
FIVE DAY TOTAL		12368	12286	7448	7801	78970	63961	26925	60107	1149809
UP TO DATE TOTAL		463490	378853	189157	175757	2959384	1972309	683803	1354208	34848513
8	5	5286	1900	1288	1615	33751	9891	4656	12444	303711
8	6	11250	9892	4360	2059	71831	51498	15761	15865	774775
8	7	4730	4926	4456	1343	30201	25645	16108	10348	411510
8	8	3056	4257	3674	3043	19513	22162	13282	23446	392012
8	9	3709	2208	1231	3457	23682	11495	4450	26636	331315
FIVE DAY TOTAL		28031	23183	15009	11517	178978	120691	54258	88738	2213323
UP TO DATE TOTAL		491521	402036	204166	187274	3138362	2092999	738060	1442946	37061837

Appendix Table 4. Smolt distribution from raw sonar counts, by array and year, Wood River, 1975-1982.

Year	Percentage of Total Counts			
	Array I	Array II	Array III	Array IV
1975[1]	68.6	31.4	-	-
1976	49.0	30.2	11.7	9.1
1977	36.0	24.4	20.8	18.8
1978	28.6	29.7	25.6	16.1
1979	17.0	27.1	33.1	22.8
1980	34.1	35.2	20.5	10.2
1981	39.2	24.8	24.9	11.1
1982	38.2	31.3	15.9	14.6

[1] Only two arrays were used in 1975.

Appendix Table 5. Mean weight and smple size of sockeye salmon smolt by year and age class, Wood River, 1977-1982[1].

Year	Age I		Age II	
	Mean Wt. (g)	n	Mean Wt. (g)	n
1977	3.5	2811	9.3	373
1978[2]	-	-	-	-
1979	7.6	953	10.1	121
1980	4.0	844	6.8	55
1981	6.3	615	8.4	284
1982	4.7	3057	8.4	394
Mean	5.2		8.6	

[1] Means are weighted by the total outmigration estimate for each 5-day sample period throughout the season.

[2] No data.

1982 NUSHAGAK AND NUYAKUK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

Samples of sockeye salmon smolt were collected from the Nuyakuk River near the outlet of the Tikchik Lake system. Samples were also taken incidentally in inclined plane traps fished near the village of Portage Creek. These inclined plane traps were used to collect indices of the chum fry population outmigration. Sockeye salmon smolt were sampled for standard age, weight, and length (AWL) data. The purpose of this study was to collect representative size and age data for smolt progeny from the record 1980 escapements of 3.0 million sockeye into the Nuyakuk and 0.3 million into the Nushagak/Mulchatna drainages.

METHODS

At the Nuyakuk River site, samples were collected using a collapsible 1.8 m fyke net anchored in the main stream with two 22.7 kg yachtsman anchors. The sample site was located approximately 2 km downriver from the lake outlet at the site selected for use in the proposed 1983 Nuyakuk River smolt enumeration study. The net was deployed during nocturnal hours and allowed to fish undisturbed until a sufficient sample was collected.

At the Nushagak River site, samples were collected using inclined plane traps that had been modified to capture outmigrating chum *(O. keta)* and pink *(O. gorbuscha)* salmon fry (Bucher 1982). Sampling took place near the village of Portage Creek some 25 km up the Nushagak River from the town of Dillingham. Outmigrating smolts captured at this location had left the rearing areas of the Tikchik Lake system, the upper Nushagak, and Mulchatna River drainages. Most of the sockeye salmon sampled at Portage Creek were presumed to come from the Nuyakuk River which drains the Tikchik Lake system.

Smolt samples were measured for length to the nearest millimeter and a scale smear collected for aging purposes. Average weights were calculated by taking the total weight of all smolt in the sample and dividing by the number within the sample.

RESULTS

Two different sampling trips were made to the Nuyakuk River in 1982. On the first trip (17 June 1982) 189 smolt samples were collected. All smolts taken

were sampled for length and weight, and the scales from 60 fish were examined for age composition. Results are presented in Table 1. The second trip was conducted on 9 July 1982 when 37 smolt were sampled. Mean length and weight increased from 74.85 to 76.78 mm and from 3.97 to 5.13 g, respectively.

Four samples of sockeye salmon smolt were taken at the Portage Creek site. All smolt were examined for length, weight, and age (Table 2).

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Table 1. Nuyakuk River sockeye salmon smolt age, weight, and length summary, 1982.

Sample No.	Date	Time	Catch	Length (mm)				Weight (g)		Age Class Composition	
				n	x	SDV	Max.-Min.	n	x	Age I	Age II
1	6/17	2200-2300	189	(189)	74.85	7.28	91-53	(189)	3.97g	100%	0
2	7/9	2200-0100	37	(37)	76.78	8.04	103-56	(37)	5.13g	97%	3%
Total			226	(226)	75.17		103-53		4.16g	99%	1%

Table 2. Nushagak River sockeye salmon smolt age, weight, and length summary, 1982.

Sample No.	Date	Length (mm) (n)	x	SDV	Max.-Min.	Weight (g) (n)	x	Age Class Composition Age I	Age II
1	6/15-6/17	(77)	73.92	8.16	89 - 53	(77)	3.97	100%	0%
2	6/21	(33)	72.39	9.26	84 - 56	(33)	3.44	100%	0%
3	6/26	(20)	76.65	6.77	95 - 65	(20)	4.66	100%	0%
4	7/ 5	(10)	82.00	3.16	86 - 77	(10)	4.43	100%	0%
Total		(140)	74.53mm		95 - 53	(140)	3.98 g	100%	0%

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