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SONAR ENUMERATION OF PACIFIC SALMON ESCAPEMENT INTO THE NUSHAGAK RIVER, 1991

By

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and

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ABSTRACT

Estimates of Pacific salmon *(Oncorhynchus sp.)* returning to the Nushagak River, Bristol Bay, Alaska were determined by hydroacoustic procedures from June 5 through August 21, 1991. Salmon were captured with drift gill nets and beach seines for species composition, and age, sex, and size information. Final estimates for each species were; 135,054 chinook *(O. tshawytscha)*, 495,106 sockeye *(O. nerka)*, 252,436 chum, *(O. keta)*, and 41,153 coho salmon *(O. kisutch)*.

KEY WORDS: Pacific salmon, sonar, Nushagak River, Portage Creek, Bristol Bay, spawning escapement, estimation, fisheries management, *Oncorhynchus*

INTRODUCTION

The Nushagak River drainage supports large runs of five species of Pacific salmon *(Oncorhynchus sp.)* which are harvested in commercial, sport, and subsistence fisheries. Accurate escapement estimates into this system are essential to make timely fishery management decisions. In 1979, the Alaska Department of Fish and Game (ADF&G) initiated a project to assess the feasibility of using hydroacoustic equipment and procedures (sonar) to count adult salmon in the Nushagak River (McBride 1979). During subsequent years, the project has provided information important to the management of the Nushagak Commercial Fishing District. During the initial years of the project, many changes were incorporated into the operation methods (McBride and Mesiar 1981, 1982; Minard 1983; Minard and Frederickson 1983; Minard 1985). Few changes have been made in sonar operations since 1985; but changes have been made in test fishing methods throughout the years (Morstad and Minard 1986, 1988; Bue 1988a, 1988b; Woolington and Bue 1989; Woolington *in press*).

The Nushagak River is located in southwestern Alaska, and flows approximately 390 km from its headwaters into Nushagak Bay, of Bristol Bay. Two main tributaries contribute to the waters of the Nushagak. The Nuyakuk River, draining Tikchik Lakes, enters from the west, and the Mulchatna River flows into the Nushagak from the east.

The sonar enumeration site was located on the Nushagak River, approximately 60 km upstream from the city of Dillingham, and 4 km downstream from the village of Portage Creek (Figure 1). This area was chosen because it is the only place in the lower Nushagak River where the entire river is contained within one channel (approximately 300 m), and the 1978 Nushagak River stock separation study concluded that salmon reaching Portage Creek were at least 93% Nushagak, Mulchatna, and Nuyakuk River stocks (McBride and Mesiar 1981). Field camp facilities were housed in canvas wall tents, on land used under a Special Use Permit from Choggiung Limited, a local village corporation.

Project objectives in 1991 were to estimate from early June through mid-August the spawning escapements for chinook, sockeye, chum, and coho salmon and to estimate the age, sex, and size composition of these escapements. Pink salmon return in even years only.

METHODS

Escapement Estimates

Estimating numbers of Pacific salmon with sonar involves three major steps:

1) estimating the number of hydroacoustic targets passing the sonar site,
2) estimating species composition of migrating salmon at the site, and
3) combining estimates of hydroacoustic targets and species composition to estimate numbers of salmon by species passing the sonar site.

Hydroacoustic Counting

Sonar equipment used for the project included four Bendix Corporation[1] side-scanning salmon counters. Design characteristics of the Bendix counters were described in King and Tarbox (1989). Gaudet (1983) provided a detailed description of the use of sonar equipment and procedures for counting salmon. Two counters were installed on the right bank[2] and two were installed on the left bank of the river. The counters on each the right and left banks were models in which one counter divided the counting range into 12 sectors, and the other which divided the counting range into 16 sectors. All counters operated at 515 kHz with a pulse width of 100 μs. Pulse repetition rate, counting range, and sensitivity were adjustable.

Pulse repetition rate was adjusted on each counter to maintain counting precision at $\pm$ 90 percent using calibration procedures described by Minard and Frederickson (1983). Counters were calibrated by comparing counts produced by a sonar counter to those recorded by a trained technician observing an oscilloscope pattern of the signal generated by that counter. Counts from the oscilloscope were hand tallied for either a ten-minute period or one hundred counts, which ever came first. At the end of the counting interval, the machine count was divided into the count from the oscilloscope to yield a percent agreement between the two. If the percent agreement was consistently less than 90% or greater than 110%, the pulse repetition rate (indicated as "Fish Swimming Speed" on the counter) was adjusted until an acceptable percent of agreement was achieved. Counters were calibrated throughout the day between 0600 h and 2400 h. Frequency of calibrations was somewhat dependent upon fish passage rates and the variability of fish swimming speeds, with at least one calibration per hour during periods of peak fish passage.

Counting range of the equipment, and the placement and number of transducers were determined by the river bottom contour (Figures 2 and 3). The river bottom at the right and left banks each sloped downward toward the middle of the river at even rates for approximately 15 to 20 m, then sloped away at a steeper rate. Because of this bottom configuration, two transducers were used on each side of the river. One (the offshore transducer for each the right and left banks) was located where the bottom contour changed, and counted outward. The inshore transducers were placed between the shore and the offshore transducers in water of sufficient depth for fish passage, and counted fish out to the offshore transducers.

Both inshore transducers were deployed within 10 m of shore. Changes in water level of the river during the 1991 field season necessitated occasional repositioning of the transducer tripods and changes in counting ranges (Table 1). The right bank inshore transducer had a counting range of 4.9 to 9.8 m , while the offshore transducer counting range was between 11.9 and 12.2 m (Figure 2).

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

[2] Right bank is the bank to the right when facing downstream.

Combined right bank counting range varied from 17.1 to 22.0 m. The left bank inshore transducer ensonified 7.6 to 19.4 m of the river, while the left bank offshore transducer ensonified between 4.9 and 11.6 m (Figure 3). Combined left bank counting range varied between 12.2 and 24.0 m. Total ensonification for right and left banks combined ranged from 32.8 to 42.6 m, approximately 12 to 18% of the total river width.

Transducers were mounted on metal tripods such that they would count from the lower portion of the water column. Minard (1985) determined that over 88% of the fish travel occurred in the lower two-fifths of the water column. All transducers were aimed for optimal counting (ie. so that the sonar beam was tangent to the river bottom) with the aid of an oscilloscope. The offshore transducers were aimed with remote-controlled pan and tilt rotators manufactured by Erin Manufacturing, Inc.[3] Inshore transducers were aimed by manually adjusting the angle of the transducer mounts on the tripods. Weirs were constructed between the bank and the inshore transducers on both sides of the river to prevent fish passage behind the transducers.

Species Composition Estimation - Test Fishing

Daily sonar counts were apportioned among salmon species using samples collected with 18.3 m (10 fathom) drift gill nets with mesh sizes of 20.7 cm and 13.0 cm, and a 45.7 m (25 fathom) beach seine. An 18.4 cm mesh gill net was also fished to collect data for evaluating the need to adjust catches for net selectivity. Sampling occurred just upstream and downstream of transducers so that catches would represent the relative abundance of fishes passing through the sonar beams. Because of the possibility that species composition was different between the inshore and offshore counting areas, sampling was conducted in inshore and offshore strata. Beach seine sets sampled only from the inshore strata. Inshore sets with gill nets were started with one end on the bank, while offshore sets were started with the near shore end of the net approximately the same distance from shore as the offshore transducer. Each size of gill net was fished for a minimum of two drifts in the inshore strata and two drifts in the offshore strata of each bank during each set of drifts. Sets of drifts began two hours before each high tide or low tide, as published in the Nushagak District tide tables. There were a minimum of two sets of drifts each day. Daily catches were pooled by strata.

Data recorded for each gill net drift included: 1) date, 2) boat operator, 3) drift number, 4) mesh size, 5) river bank (right or left), 6) counting area (inshore or offshore), 7) net length in fathoms, 8) fishing time, 9) number of each species of fish caught, 10) length, mid-eye to fork of tail of each fish caught (nearest 5 mm). The following times were recorded for each drift:

Time net started out	-	Hr:Min:Sec
Time net full out	-	Hr:Min:Sec
Time net started in	-	Hr:Min:Sec
Time net full in	-	Hr:Min:Sec

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

When the fish passage rate of the right or left bank exceeded 500 fish per hour, beach seines were used to sample the inshore strata while gill nets were used to sample the offshore strata.

Proportions by species used in this report were not based on relative catch per unit effort data (CPUE) or adjusted for net selectivity. Instead, proportions by species were calculated by simply dividing species catch by total catch of combined gill net or beach seine sets through time and location. CPUE and fish length data were collected to evaluate the application of species apportionment techniques used on the Yukon River (Mesiar et al 1991 and Fleishman et al. 1992) and will be reported in a separate publication at a later date. Consequently, final escapement estimates by species for Nushagak River in 1991 may change in the future depending on results from CPUE and net selectivity analyses.

Salmon Escapement Estimation

A stratified sampling design was used to make escapement estimates. Strata were defined by river bank (left and right) and transducer location (inshore and offshore counting areas). On days when beach seining was not effective, sonar counts were apportioned by species based on the gill net catch from each strata. On days of high salmon passage, beach seine catches were used to apportion inshore counts, and offshore gill net catches were used for offshore sonar counts.

Sonar counts for each location (right and left river bank, inshore and offshore) were apportioned to species on a daily basis. The desired sample size for each time-location strata was 100 salmon (Appendix A.1). Based on Thompson's (1987) "worst case" parameter value for a multinomial distribution, a sample size of 100 salmon would result in simultaneously estimating the true proportion for each species within 10 percentage points 90% of the time. If less than 100 salmon were captured each day in a spatial strata, catches from the same gear type (beach seine or gill net) from subsequent days were pooled by location until 100 salmon were obtained. Proportions based on catches pooled through time by location were applied to daily sonar counts. A new temporal strata was begun once 100 salmon were captured within each spatial strata, or when a different gear type was used. If the sample goal of 100 salmon per spatial strata per gear type was not attained within approximately seven days, a new temporal strata was begun regardless of sample size.

Daily estimates for each salmon species were determined for each strata using the relationship:

$$\hat{N}_{ijk} = c_{jk}\left(\frac{n_{ikl}}{\sum_{i} n_{ikl}}\right) \qquad (1)$$

where:

$\hat{N}_{ijk}$ = the estimated number of Pacific salmon of species i on day j, which migrated past strata k,

c_{jk} = the number of sonar counts recorded on day j for strata k, and

n_{ikl} = the number of Pacific salmon of species i caught in strata k and time period l using beach seine or 20.7 cm and 13.0 cm mesh gill nets.

Daily escapement for each species was determined by summing strata estimates:

$$\hat{N}_{ij} = \sum_{k} N_{ijk} \tag{2}$$

Cumulative numbers of Pacific salmon were estimated by summing daily estimates:

$$\hat{N}_{i} = \sum_{j} \hat{N}_{ij} \tag{3}$$

Age, Sex, and Size Sampling

Age, sex, and size data (AWL) were collected from sockeye, chum, chinook, and coho salmon migrating past the sonar site. Only sockeye and chum salmon captured with beach seines were sampled for AWL data to avoid size selectivity of gill nets. All chinook and coho salmon captured by either gear type were sampled to increase the number of AWL samples

Sampling goals by species for the entire season were: 1,200 sockeye, 600 chinook, 400 chum, and 250 coho salmon. The desired level of accuracy and precision for sockeye and chinook salmon age composition was 0.05. Based on Thompson's (1987) work, a sample size of 510 readable scales would simultaneously estimate the true percentage of each major age class within 5 percentage points, 95% of the time. A sample size of 600 per strata was set for sockeye and chinook to account for regenerated and unageable scales. Two time strata were desired for sockeye salmon, therefore the goal for the season was set at 1,200. A sample size of 400 chum and 250 coho salmon scales ensured simultaneously estimating the true percentage of each major age class within 5 percentage points, 90% of the time.

Because of the high rate of scale regeneration among chinook and coho salmon,

three scales were collected from each fish. Only one scale per fish was collected from sockeye and chum salmon. Fish were measured to the nearest millimeter from the middle of the eye to the fork of the tail. Sex was determined from external characteristics. AWL data were recorded on Mark-Sense forms, which were read by an optical scanner (Stratton 1990). Age, expressed in European notation, was determined post seasonally from scale samples.

Climatological Data

Weather data were collected at 0800 and 2000 hours each day. Precipitation was measured using a Taylor Clear View[4] rain gauge; wind direction and velocity were estimated; and air and water temperatures were measured with a hand-held mercury thermometer.

RESULTS

Counting began on June 5 and continued through August 21 (Appendices B.1-B.4). More counts were recorded from the left bank (531,539) than from the right bank (392,213). A total of 3,253 drifts with gill nets and 66 sets with a seine captured 3,274 salmon for species apportionment data and AWL information. The first salmon was caught June 7, while the first sockeye salmon was caught June 16. Counts prior to June 15 were assumed to be 100% chinook salmon. Only 13.0 cm mesh nets were fished after July 25. The last salmon was caught on August 13 and test fishing was terminated August 14. Counts after August 13 were assumed to be 100% coho salmon. Climatological observations recorded during the 1991 field season are listed in Appendix C.1.

Distribution of Sonar Counts

Spatial Distribution

Information on the distribution of fish in the river is important in considering the reliability of the estimates generated by the sonar counts. If appreciable numbers of fish were migrating upstream in areas of the river not ensonified by the sonar, then the estimates would be low.

Most sonar counts for the right (Figure 4) and left (Figure 5) banks were recorded by the inshore sonar counters (87% and 93% respectively). The outer half of the right bank offshore counting range accounted for only 2.9% of the

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

total right bank sonar counts (Figure 6), and the outer half of the left bank offshore counting range accounted for only 2.6% of the total left bank sonar counts (Figure 7). Few counts occurring at the end of the counting range suggests that the majority of fish passage upriver occurred within the counting ranges of the sonar equipment. Counts did occur at the end of the right bank offshore counting range for one day in each June and July, and for several days during June at the end of the left bank offshore counting range.

The distribution of each species within the counting ranges is difficult to determined because the sonar equipment does not have the ability to differentiate between species. Figures 4 through 7 show peak counts occurring on June 24, June 29, and July 4; days of peak passage of chinook, chum, and sockeye salmon as suggested by test fish catches. The distribution of counts on June 29 and July 4 suggests that chum and sockeye tend to migrate close to the shore.

The offshore distribution of chinook salmon is of great concern in regards to the reliability of the chinook salmon escapement estimate. Minard and Frederickson (1983), and Minard (1985) suggested that chinook salmon occurred further out in the river than the other species. Figures 4 and 5 show peak offshore sonar counts occurring on June 24, the same day as peak chinook passage. Relatively few counts occurred in the outer sectors of the right offshore transducer, but counts peaked on this day in the outer sectors of the left offshore transducer. Although there were a few days during which appreciable counts occurred in the outer sectors of the offshore transducers, the vast majority of counts occurred in the inshore transducers or inshore sectors of the offshore transducers.

Temporal Distribution

Information on patterns of hourly fish passage are of interest to determine optimal times for scheduling test fishing and equipment calibration. Any, or all of a combination of variables such as: tide; weather (winds, rainfall, etc.); time, date, and duration of commercial fishing periods; and hours of daylight, might influence when migrating fish would pass the sonar site. No clear pattern of fish passage through time was discerned. Trends of hourly counts from both sides of the river seemed comparable (Table 2; Figures 8 and 9).

Figures 10 shows the hourly distribution of counts recorded by the inshore and offshore counters for each bank. Again, no clear pattern of fish passage through time seemed evident.

Previous work at the sonar site suggested that counts tended to peak during the lower of the two high tide stages each day (McBride and Mesiar 1981). Water levels at the sonar site were influenced by tide. Times of high and low water at the sonar site were typically 2 to 3 hours after the times of high and low tides published in the tide tables for Nushagak Bay. Further work is needed to investigate the relationship between the times of peak water levels and the effects on fish passage.

Chinook Salmon

The 1991 escapement estimate for chinook salmon was 135,054 (Table 3 and Appendix D.1). This estimate was 180% of the escapement goal of 75,000; exceeding the management range of 50,000 to 100,000 chinook salmon.

Run timing of chinook salmon for 1991 appeared similar to previous eight years (Appendix D.2). Chinook salmon were estimated to pass the sonar site from June 5 until August 13. The peak day of chinook salmon passage occurred on June 24 with an estimate of 24,266. This was the highest daily estimate for chinook salmon since sonar estimates began in 1980.

This was the fourth year information on age, sex, and size of chinook salmon was collected at the sonar site (Table 4). Age, sex, and length were determined for 542 of the 664 chinook salmon sampled. Three major age classes were present: age-1.3 (1986 brood year); -1.4 (1985 brood year); and -1.2 (1987 brood year). These age classes represented 37%, 33%, and 28% of the chinook salmon escapement. The percentages of males and females were 58% and 42% respectively. Mean length by age ranged from 371 to 922 mm (Table 4).

Sockeye Salmon

Though the sonar equipment was operational by June 5, species proportion data indicate there were no sockeye salmon until June 15 (Table 3 and Appendix E.1). The 1991 escapement estimate for sockeye salmon was 495,106. This estimate was 90% of the escapement goal of 550,000; within the management range of 340,000 to 760,000 sockeye salmon.

Run timing of sockeye salmon for 1991 appeared similar to previous years (Appendix E.2). Sockeye salmon were estimated to pass the sonar site from June 15 until August 13. The peak day of sockeye salmon passage occurred on July 4 with an estimate of 97,608 sockeye, 20% of the entire 1991 escapement estimate.

This was the thirteenth year information on age, sex, and size of sockeye salmon was collected at the sonar site (Table 5). Age, sex, and length were determined for 632 of the 827 sockeye salmon sampled. High water conditions during the peak of the run made beach seining difficult which resulted in less sockeye salmon sampled than the goal. Age-0.3 (1987 brood year) and -1.3 (1986 brood year) sockeye salmon predominated (39% and 52%). The percentages of males and females were 62% and 38% respectively. Mean length by age ranged from 414 to 600 mm (Table 5).

Chum Salmon

Run timing of chum salmon in 1991 was similar to that of sockeye salmon in that chum salmon were not estimated to be present until June 15 (Table 3 and Appendix

F.1). The 1991 escapement estimate for chum salmon was 252,436. This estimate was 72% of the escapement goal of 350,000.

Seasonal run timing appeared similar to previous years (Appendix F.2). The peak day for chum salmon passage occurred on July 4; the same day as peak sockeye salmon estimates. Chum salmon were counted past the sonar site from June 15 through August 8.

This was the twelfth year information on age, sex, and size of chum salmon was collected at the sonar site (Table 6). Age, sex, and, length were determined for 364 of the 422 chum salmon sampled. Age-0.3 (1987 brood year) and -0.4 (1986 brood year) chum salmon predominated (59% and 39%). The percentages of males and females were 57% and 43% respectively. Mean length by age ranged from 551 to 628 mm (Table 6).

Coho Salmon

Coho salmon were estimated to have started migrating past the sonar site on July 15 (Table 3 and Appendix G.1). Test fishing was terminated on August 14 and counting activity ended on August 21. All counts recorded between these dates were assumed to be 100% coho salmon. The 1991 escapement estimate for coho salmon was 41,153 through August 21. This was 27% of the escapement goal of 150,000.

Run timing for coho salmon in 1991 appeared similar to previous years (Appendix G.2). The peak day of coho salmon passage occurred July 29, with an estimate of 7,552 coho salmon.

This was the ninth year information on age, sex, and size of coho salmon was collected at the sonar site. Age, sex, and length were determined for 147 of the 182 coho salmon sampled (Table 7). The 1991 coho salmon run consisted of 12% age-1.1 (1988 brood year) and 88% age-2.1 (1987 brood year) fish. The percentages of males and females were 56% and 44% respectively. Mean length by age ranged from 525 (age-2.1) to 533 mm (age 1.1; Table 7).

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Table 1. Counting ranges for sonar counters on right and left banks, Nushagak River sonar, 1991.

Right Bank				Left Bank			
Inshore		Offshore		Inshore		Offshore	
Dates	Distance[a](m)	Dates	Distance (m)	Dates	Distance (m)	Dates	Distance (m)
6 05 - 6 19	6.1	6 05 - 8 17	12.2	6 05 - 6 19	10.7	6 05 - 6 26	10.7
6 19 - 6 21	5.9	8 17 - 8 21	11.9	6 19 - 6 25	10.4	6 26 7 01	11.6
6 22 - 6 23	6.0			6 25 - 6 26	10.0	7 01 - 7 02	11.3
6 23 - 6 27	6.1			6 26 - 7 01	9.7	7 02 - 7 03	8.8
6 27 - 6 30	5.8			7 01 - 7 02	12.7	7 03 - 7 08	4.9
6 30 - 7 03	6.4			7 02	19.4[b]	7 08 - 8 21	4.6
7 03 - 7 06	6.1			7 02 - 7 11	13.7		
7 06 - 7 08	6.4			7 11 - 7 15	13.6		
7 08 - 7 09	6.1			7 15 - 7 23	13.4		
7 09 - 7 20	5.8			7 23	13.1		
7 20 - 7 21	4.9			7 23 - 7 30	13.4		
7 21 - 7 22	6.1			7 30 - 8 21	7.6		
7 22	5.5						
7 23 - 7 25	4.9						
7 25 - 7 29	9.8						
7 30 - 8 04	9.4						
8 04 - 8 21	8.7						

[a] Total distance from the transducer that the sonar beam could count fish.

[b] Left bank offshore transducer inoperative on July 2, so the inshore counting range was extended.

Table 2. Daily sonar counts, right and left banks, Nushagak River sonar, 1991.

	Right Bank Daily Sonar Counts Time, Midnight through:					Left Bank Daily Sonar Counts Time, Midnight through:				
Date	0600	1000	1400	1800	2400	0600	1000	1400	1800	2400
6 05	-	-	-	48	227	-	-	-	18	63
6 06	79	135	214	309	383	30	41	49	62	90
6 07	48	115	202	259	312	8	12	30	37	44
6 08	57	100	157	219	258	4	6	30	45	64
6 09	63	101	146	194	243	10	17	33	42	71
6 10	69	126	216	275	351	23	35	51	63	92
6 11	71	108	159	202	246	17	29	31	49	96
6 12	80	132	168	190	258	27	44	65	87	128
6 13	82	114	145	175	226	21	46	60	91	104
6 14	41	77	100	147	224	8	18	24	47	79
6 15	69	136	283	630	2,414	15	26	96	215	877
6 16	1,492	1,868	2,978	4,542	5,686	884	2,653	3,403	3,953	4,779
6 17	302	440	585	1,021	1,501	468	854	1,614	2,267	2,837
6 18	369	506	704	978	1,281	296	648	1,090	1,791	2,521
6 19	189	275	403	623	846	370	546	848	1,213	1,425
6 20	265	426	604	1,387	1,877	132	199	315	478	664
6 21	640	856	1,066	1,559	2,366	232	387	219	667	850
6 22	728	1,290	2,269	3,331	4,533	207	313	476	688	971
6 23	2,005	3,608	5,202	6,543	9,827	624	1,014	1,284	1,464	2,138
6 24	6,880	12,875	18,554	27,592	38,185	4,564	10,702	15,276	21,869	28,433
6 25	6,366	9,165	10 960	13,905	21,207	5,282	7,123	8,532	10,004	14,051
6 26	6,920	10,541	13,397	15,988	21,574	4,110	5,616	6,634	7,476	9,590
6 27	4,128	7,071	10,186	12,074	15,328	1,779	2,983	4,623	5,531	7,242
6 28	4,548	6,401	7,753	8,862	15,785	3,398	5,008	6,350	7,595	11,917
6 29	5,896	10,180	14,167	18,112	20,509	14,535	19,024	29,616	33,763	39,509
6 30	4,240	7,100	8,830	9,881	11,813	7,327	9,787	12,160	13,596	20,479
7 01	4,738	8,722	10,348	11,886	12,931	17,418	32,229	42,996	43,647	57,374
7 02	2,181	3,693	4,714	5,384	6,171	6,059	11,387	16,779	21,048	30,063
7 03	2,807	6,073	9,019	13,509	22,305	17,589	26,399	40,893	50,516	88,415
7 04	24,914	33,544	42,544	46,996	52,991	37,516	51,816	69,139	81,148	107,433
7 05	7,247	12,111	14,903	16,696	18,406	17,773	27,241	32,134	34,542	36,310
7 06	1,179	1,800	2,285	2,662	3,288	1,603	2,356	2,875	3,391	3,679
7 07	565	889	1,293	1,652	2,246	440	740	997	1,272	1,591
7 08	461	711	919	1,153	1,752	461	627	764	935	1,155
7 09	360	593	739	941	1,375	311	494	580	657	874
7 10	694	1,114	1,310	1,525	2,239	312	448	513	586	752
7 11	840	1,576	1,938	2,325	3,730	434	686	934	1,267	1,775
7 12	1,499	2,363	2,708	3,098	3,834	1,952	2,619	2,957	3,493	4,085
7 13	850	1,352	1,645	2,172	2,788	457	684	856	1,065	1,430
7 14	772	1,397	2,274	2,745	4,127	332	856	1,112	1,345	1,813
7 15	1,025	1,395	1,953	2,427	3,132	408	656	837	998	1,278
7 16	556	1,026	2,140	2,797	5,332	131	236	459	632	2,008
7 17	1,702	2,622	4,145	6,496	9,386	584	725	1,184	1,766	2,774
7 18	2,607	3,883	5,230	7,361	10,348	636	1,106	2,047	2,793	3,822
7 19	1,915	3,622	5,293	8,078	10,731	1,085	1,651	2,555	3,614	4,203
7 20	1,609	2,849	3,628	4,673	5,620	926	1,318	1,625	1,864	2,202
7 21	841	1,142	1,384	2,112	3,294	704	1,007	1,220	1,408	1,714
7 22	1,682	3,085	3,726	4,871	6,020	495	1,367	1,835	2,270	2,542
7 23	1,105	2,008	2,714	3,432	3,959	332	650	844	1,055	1,305

-Continued-

Table 2. (p 2 of 2)

	Right Bank Daily Sonar Counts Time, Midnight through:					Left Bank Daily Sonar Counts Time, Midnight through:				
Date	0600	1000	1400	1800	2400	0600	1000	1400	1800	2400
7 24	280	511	610	698	840	108	207	263	349	425
7 25	154	222	305	370	434	100	135	185	224	259
7 26	168	242	272	381	531	62	91	117	152	193
7 27	94	202	311	381	501	60	102	140	205	251
7 28	61	195	319	638	1,557	34	79	108	230	1,021
7 29	769	1,539	2,422	3,520	5,455	219	791	2,299	3,400	4,509
7 30	563	1,026	1,409	1,722	2,058	182	707	1,463	1,770	2,485
7 31	379	523	649	794	865	171	284	506	571	769
8 01	343	502	634	754	896	108	185	337	466	722
8 02	111	233	648	979	1,263	153	268	1,111	1,554	2,080
8 03	124	257	414	499	628	142	329	612	717	894
8 04	79	152	299	348	418	138	247	353	509	815
8 05	16	54	90	155	217	115	224	313	448	604
8 06	67	130	186	296	418	244	553	713	763	1,164
8 07	34	82	125	155	245	110	257	347	394	654
8 08	72	137	162	183	203	52	108	143	182	283
8 09	73	126	143	174	218	52	120	205	251	393
8 10	31	91	114	149	333	30	86	135	172	461
8 11	78	128	173	207	364	77	232	275	321	537
8 12	75	147	198	228	314	159	427	508	575	936
8 13	11	50	72	103	142	127	271	326	398	953
8 14	5	23	50	65	95	193	360	467	520	1,431
8 15	31	55	77	103	136	5	44	98	467	1,482
8 16	34	63	139	178	210	76	93	131	151	167
8 17	26	36	59	75	101	12	27	36	51	63
8 18	9	39	72	101	149	69	78	86	98	119
8 19	8	15	22	34	48	33	43	46	64	80
8 20	17	44	59	71	84	10	19	33	47	60
8 21	8	17	25	25	25	11	17	18	18	18
Total	111,491	178,148	236,358	300,423	392,213	155,181	240,813	330,421	389,490	531,539

Table 3. Daily salmon escapement estimates, Nushagak River sonar, 1991.

	Chinook		Sockeye		Chum		Coho	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
6 05	290	290	0	0	0	0	0	0
6 06	473	763	0	0	0	0	0	0
6 07	356	1,119	0	0	0	0	0	0
6 08	322	1,441	0	0	0	0	0	0
6 09	314	1,755	0	0	0	0	0	0
6 10	443	2,198	0	0	0	0	0	0
6 11	342	2,540	0	0	0	0	0	0
6 12	386	2,926	0	0	0	0	0	0
6 13	330	3,256	0	0	0	0	0	0
6 14	303	3,559	0	0	0	0	0	0
6 15	2,184	5,743	411	411	696	696	0	0
6 16	7,492	13,235	855	1,266	2,118	2,814	0	0
6 17	3,375	16,610	247	1,513	716	3,530	0	0
6 18	2,985	19,595	219	1,732	598	4,128	0	0
6 19	1,747	21,342	137	1,869	387	4,515	0	0
6 20	1,682	23,024	314	2,183	545	5,060	0	0
6 21	1,384	24,408	867	3,050	965	6,250	0	0
6 22	2,196	26,604	1,565	4,615	1,743	7,768	0	0
6 23	4,807	31,411	3,407	8,022	3,751	11,519	0	0
6 24	24,266	55,677	8,830	16,852	33,521	45,040	0	0
6 25	11,349	67,026	11,476	28,328	12,433	57,473	0	0
6 26	9,022	76,048	10,667	38,995	11,476	68,949	0	0
6 27	5,098	81,146	5,084	44,079	12,388	81,337	0	0
6 28	5,515	86,661	13,962	58,041	8,244	89,561	0	0
6 29	2,379	89,040	54,173	112,214	3,466	93,027	0	0
6 30	7,422	96,462	16,097	128,311	8,773	101,800	0	0
7 01	2,866	99,328	60,848	189,159	6,592	108,392	0	0
7 02	9,686	109,014	17,820	206,979	8,728	117,120	0	0
7 03	965	109,979	91,915	298,894	17,840	134,960	0	0
7 04	2,927	112,906	97,608	396,502	59,888	194,848	0	0
7 05	1,636	114,542	34,640	431,142	18,440	213,288	0	0
7 06	1,894	116,436	3,670	434,812	1,403	214,691	0	0
7 07	977	117,413	2,024	436,836	835	215,526	0	0
7 08	780	118,193	1,492	438,328	635	216,161	0	0
7 09	561	118,754	1,189	439,517	499	216,660	0	0
7 10	580	119,334	1,676	441,193	734	217,394	0	0
7 11	1,142	120,476	3,068	444,261	1,296	218,690	0	0
7 12	1,970	122,446	4,318	448,579	1,632	220,322	0	0
7 13	919	123,365	2,324	450,903	975	221,297	0	0
7 14	1,166	124,531	3,346	454,249	1,429	222,736	0	0
7 15	897	124,428	2,302	456,551	1,084	223,810	127	127
7 16	1,350	126,778	3,926	460,477	1,844	225,654	221	348
7 17	1,564	128,342	6,548	467,025	3,478	229,132	570	918
7 18	920	129,262	9,526	476,551	3,018	232,150	706	1,624
7 19	1,150	130,412	8,750	485,301	3,901	236,051	1,133	2,757
7 20	1,180	131,592	3,205	488,506	2,922	238,973	515	3,272
7 21	676	132,268	1,840	490,346	1,756	240,729	736	4,008
7 22	683	132,951	1,886	492,232	3,732	244,461	2,261	6,269
7 23	490	133,441	1,402	493,634	2,394	246,855	978	7,247
7 24	144	133,585	298	493,932	567	247,422	256	7,503
7 25	73	133,658	176	494,108	344	247,766	99	7,602
7 26	64	133,722	179	494,287	322	248,088	159	7,761

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Table 3. (p 2 of 2)

	Chinook		Sockeye		Chum		Coho	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
7 27	26	133,748	36	494,323	122	248,210	568	8,329
7 28	111	133,859	101	494,424	406	248,616	1,959	10,288
7 29	456	134,315	367	494,791	1,588	250,204	7,552	17,840
7 30	517	134,832	152	494,943	756	250,960	3,117	20,957
7 31	90	134,922	64	495,007	269	251,229	1,211	22,168
8 01	48	134,970	65	495,072	263	251,492	1,242	23,410
8 02	0	134,970	0	495,072	327	251,819	3,016	26,426
8 03	0	134,970	0	495,072	137	251,956	1,385	27,811
8 04	0	134,970	0	495,072	118	252,074	1,115	28,926
8 05	0	134,970	0	495,072	76	252,150	745	29,671
8 06	0	134,970	0	495,072	158	252,308	1,424	31,095
8 07	0	134,970	0	495,072	87	252,395	812	31,907
8 08	0	134,970	0	495,072	41	252,436	445	32,352
8 09	15	134,985	5	495,077	0	252,436	591	32,943
8 10	22	135,077	7	495,084	0	252,436	764	33,707
8 11	20	135,027	10	495,094	0	252,436	1,224	35,802
8 12	18	135,045	9	495,103	0	252,436	1,224	35,802
8 13	9	135,054	3	495,106	0	252,436	1,083	36,855
8 14	0	135,054	0	495,106	0	252,436	1,526	38,411
8 15	0	135,054	0	495,106	0	252,436	1,618	40,029
8 16	0	135,054	0	495,106	0	252,436	377	40,406
8 17	0	135,054	0	495,106	0	252,436	164	40,570
8 18	0	135,054	0	495,106	0	252,436	268	40,838
8 19	0	135,054	0	495,106	0	252,436	128	40,966
8 20	0	135,054	0	495,106	0	252,436	144	41,110
8 21	0	135,054	0	495,106	0	252,436	43	41,153

Table 4. Age, sex, and size composition of chinook salmon escapement, Nushagak River sonar, 1991.

	Age Group						
	1.1	1.2	1.3	1.4	1.5	2.4	Total
Males	498	27,160	29,154	20,682	498		77,992
Percent	0.4	20.1	21.6	15.3	0.4		57.8
Mean Length (mm)	371	551	731	852	883		699
Std. Error	35	7	10	11	23		5
Sample Size	2	109	117	83	2		313
Females		11,462	20,183	23,922	1,246	249	57,062
Percent		8.5	14.9	17.7	0.9	0.2	42.2
Mean Length (mm)		589	759	844	937	800	765
Std. Error		13	12	7	8		6
Sample Size		46	81	96	5	1	229
Both Sexes	498	38,622	49,337	44,604	1,744	249	135,054
Percent	0.4	28.6	36.5	33.0	1.3	0.2	100.0
Mean Length (mm)	371	563	742	848	922	800	727
Std.Error	35	7	8	6	9		4
Sample Size	2	155	198	179	7	1	542

Table 5. Age, sex, and size composition of sockeye salmon escapement, Nushagak River sonar, 1991.

	Age Group							
	0.2	0.3	1.2	0.4	1.3	1.4	2.3	Total
Males	13,049	121,282	9,211	7,676	150,451	2,303	768	304,740
Percent	2.6	24.5	1.9	1.5	30.4	0.5	0.2	61.6
Mean Length (mm)	407	548	448	612	568	579	603	551
Std. Error	4	4	12	15	2	23		2
Sample Size	17	156	12	10	193	3	1	392
Females	1,535	70,620	2,303	6,606	105,929	3,070	2,303	190,366
Percent	0.3	14.2	0.5	0.9	21.4	0.6	0.5	38.4
Mean Length (mm)	482	536	476	580	541	584	552	540
Std. Error	49	2	11	7	2	13	12	1
Sample Size	2	88	3	6	134	4	3	240
Both Sexes	14,584	191,902	11,514	12,282	256,380	5,373	3,071	495,106
Percent	2.9	38.8	2.3	2.5	51.8	1.1	0.6	100.00
Mean Length (mm)	414	544	454	600	557	582	565	546
Std. Error	6	3	10	10	2	12	12	1
Sample Size	19	244	15	16	327	7	4	632

Table 6. Age, sex, and size composition of chum salmon escapement, Nushagak River sonar, 1991.

	Age Group				
	0.2	0.3	0.4	0.5	Total
Males	2,075	82,301	58,786	692	143,854
Percent	0.8	32.6	23.3	0.3	57.0
Mean Length (mm)	554	577	593	630	583
Std. Error	9	3	4		2
Sample Size	3	118	85	1	207
Females	692	67,085	40,113	692	108,582
Percent	0.3	26.5	15.9	0.3	43.0
Mean Length (mm)	540	544	563	625	552
Std. Error		3	4		2
Sample Size	1	97	58	1	157
Both Sexes	2,767	149,386	98,899	1,384	252,436
Percent	1.1	59.1	39.2	0.6	100.0
Mean Length (mm)	551	562	581	628	570
Std. Error	9	2	3		2
Sample Size	4	215	143	2	364

Table 7. Age, sex, and size composition of coho salmon escapement, Nushagak River sonar, 1991.

	Age Group		
	1.1	2.1	Total
Males	3,079	20,157	23,236
Percent	7.5	49.0	56.5
Mean Length (mm)	534	504	508
Std. Error	15	6	5
Sample Size	11	72	83
Females	1,680	16,237	17,917
Percent	4.1	39.4	43.5
Mean Length (mm)	531	552	550
Std. Error	17	6	5
Sample Size	6	58	64
Both Sexes	4,759	36,394	41,153
Percent	11.6	88.4	100.0
Mean Length (mm)	533	525	526
Std. Error	11	4	4
Sample Size	17	130	147

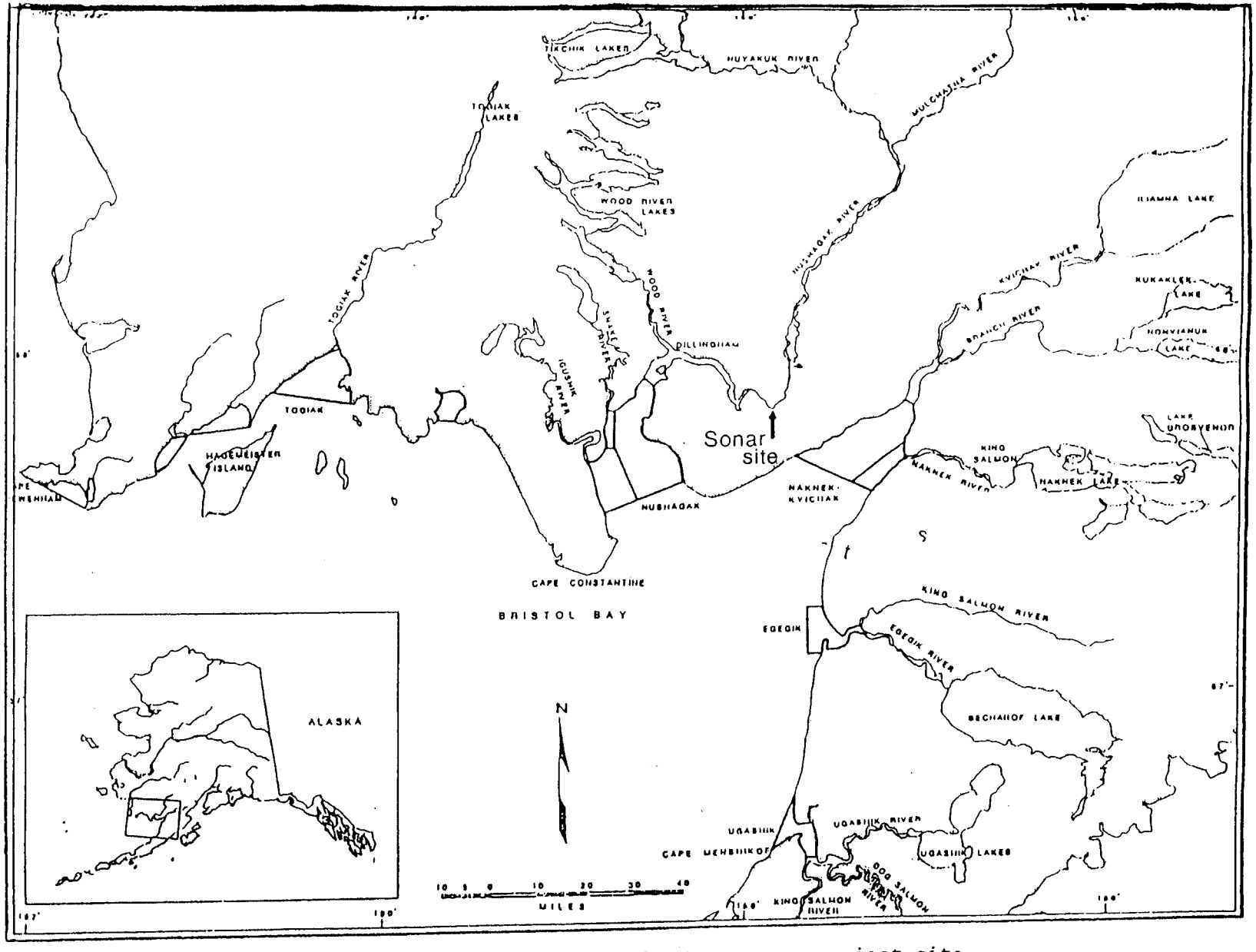

Figure 1. Bristol Bay area with location of Nushagak River sonar project site.

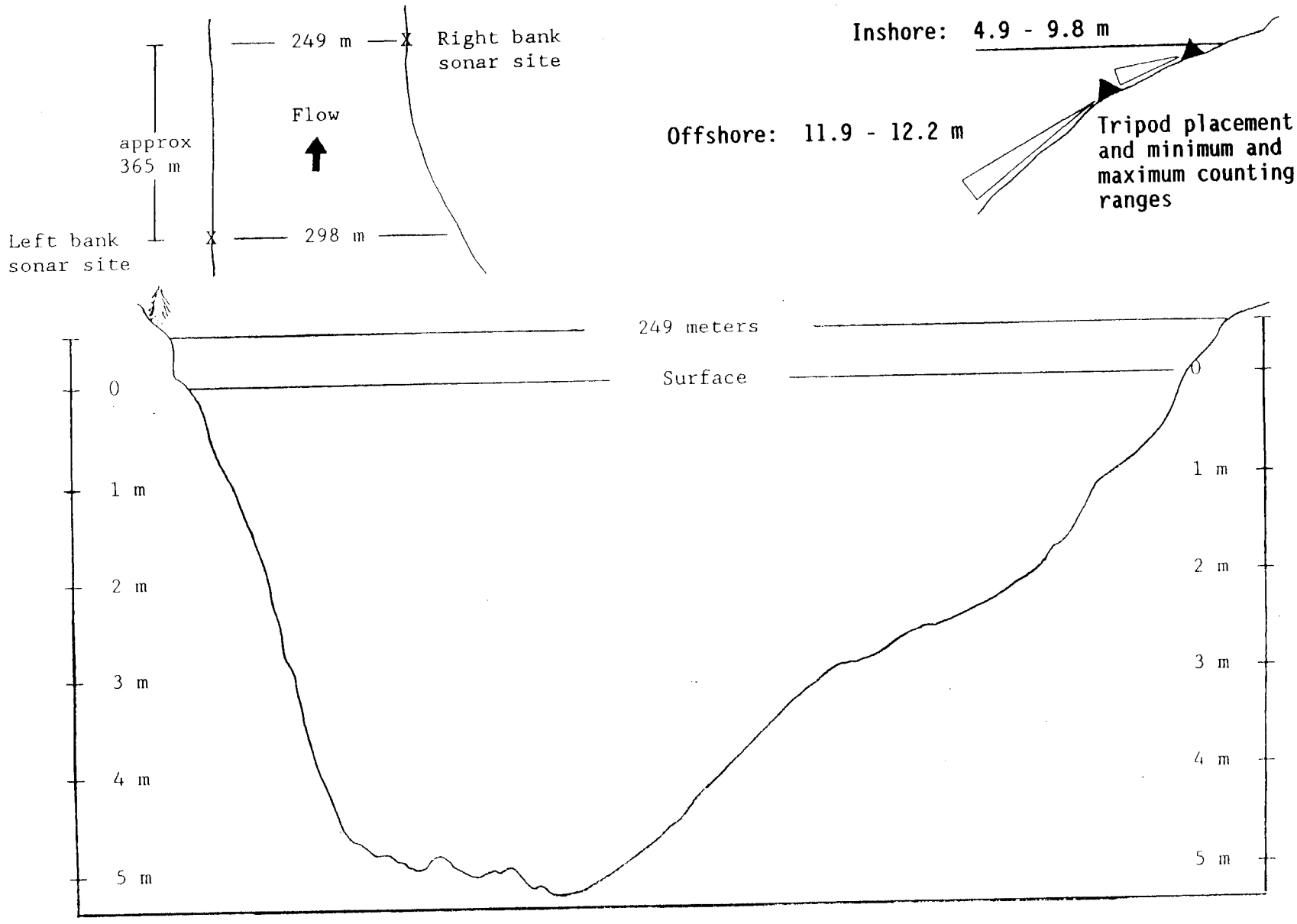

Figure 2. Bottom profile of Nushagak River at right bank sonar site.

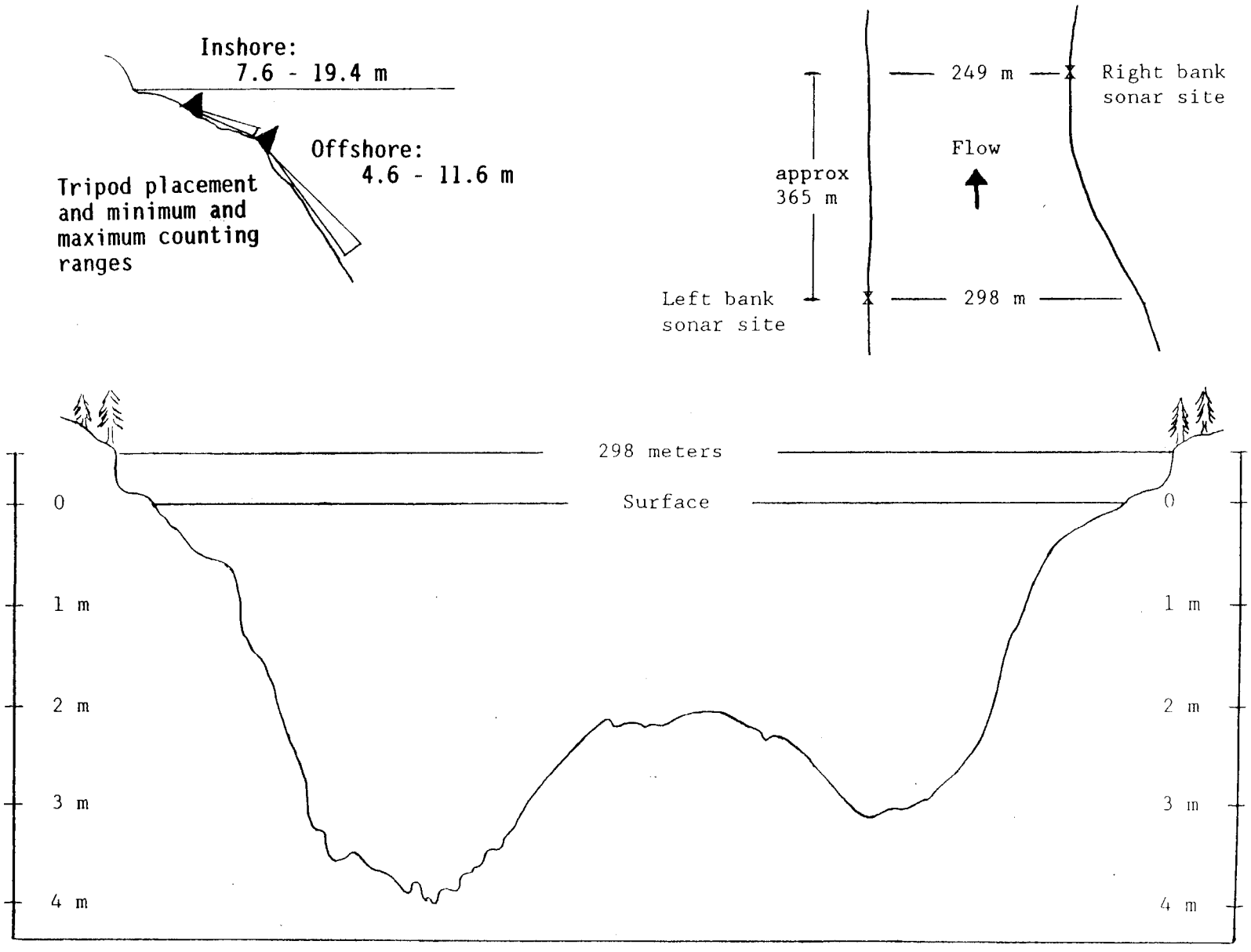

Figure 3. Bottom profile of Nushagak River at left bank sonar site.

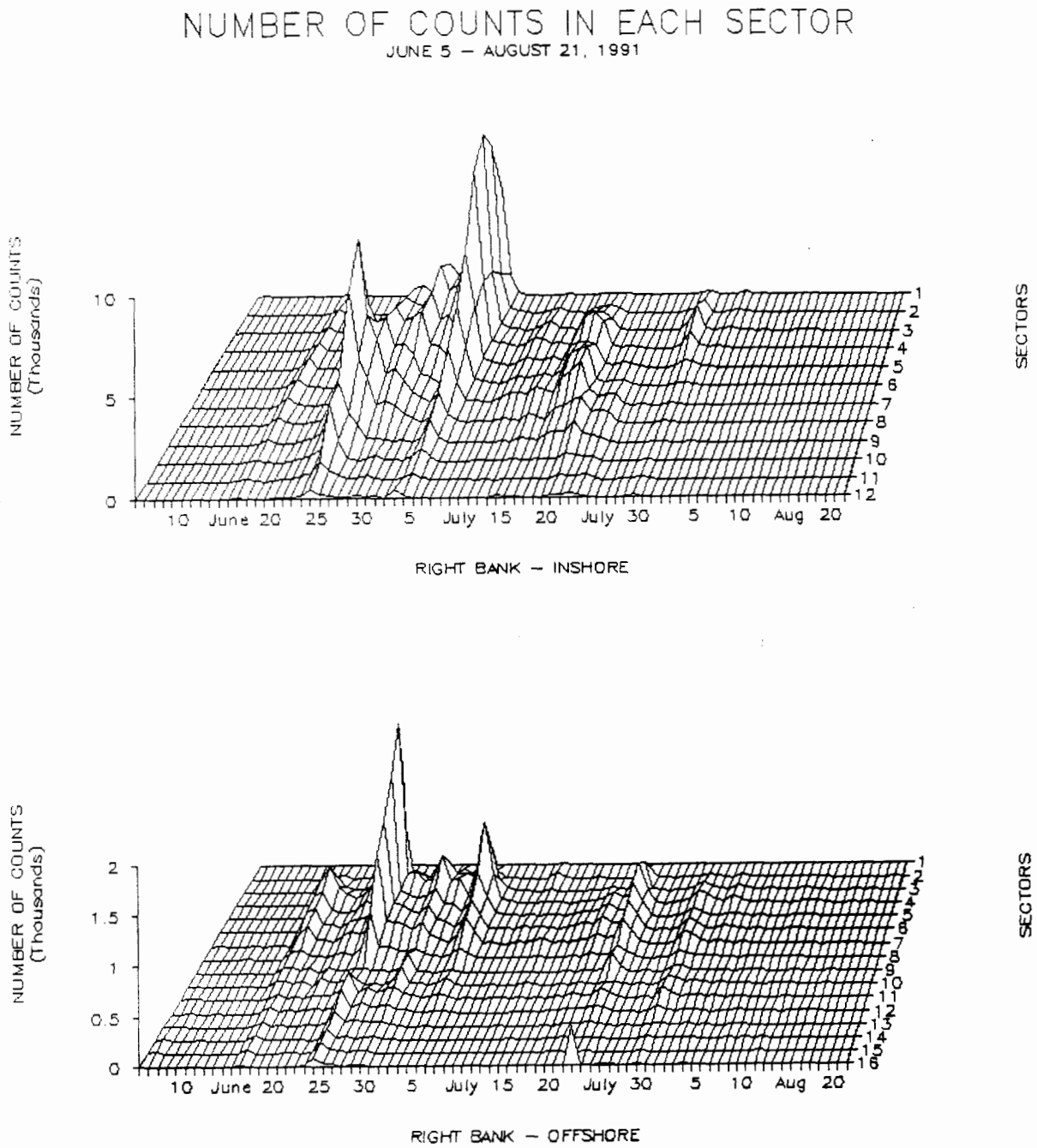

Figure 4. Sonar counts by sector, for the right bank, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

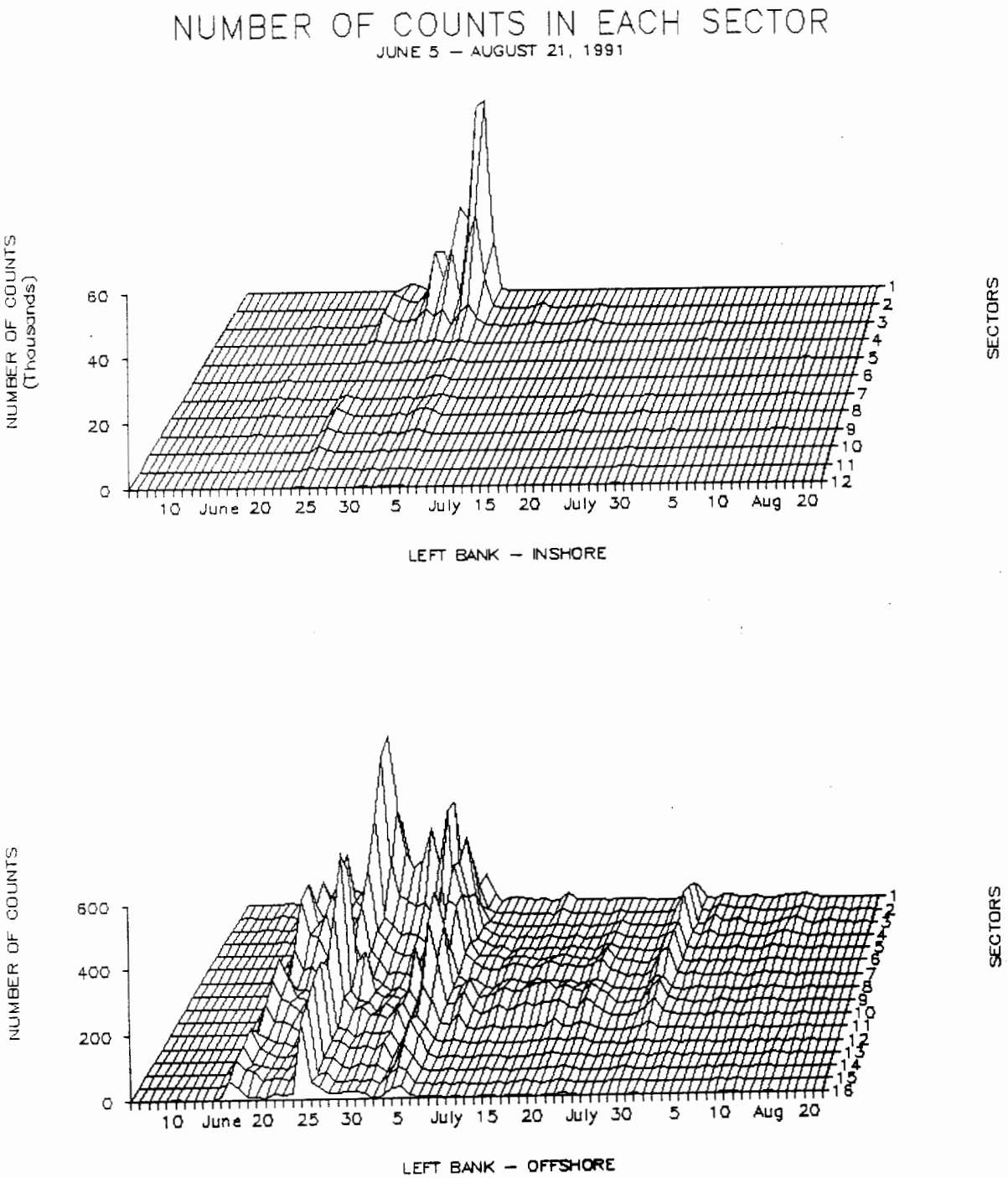

Figure 5. Sonar counts by sector, for the left bank, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

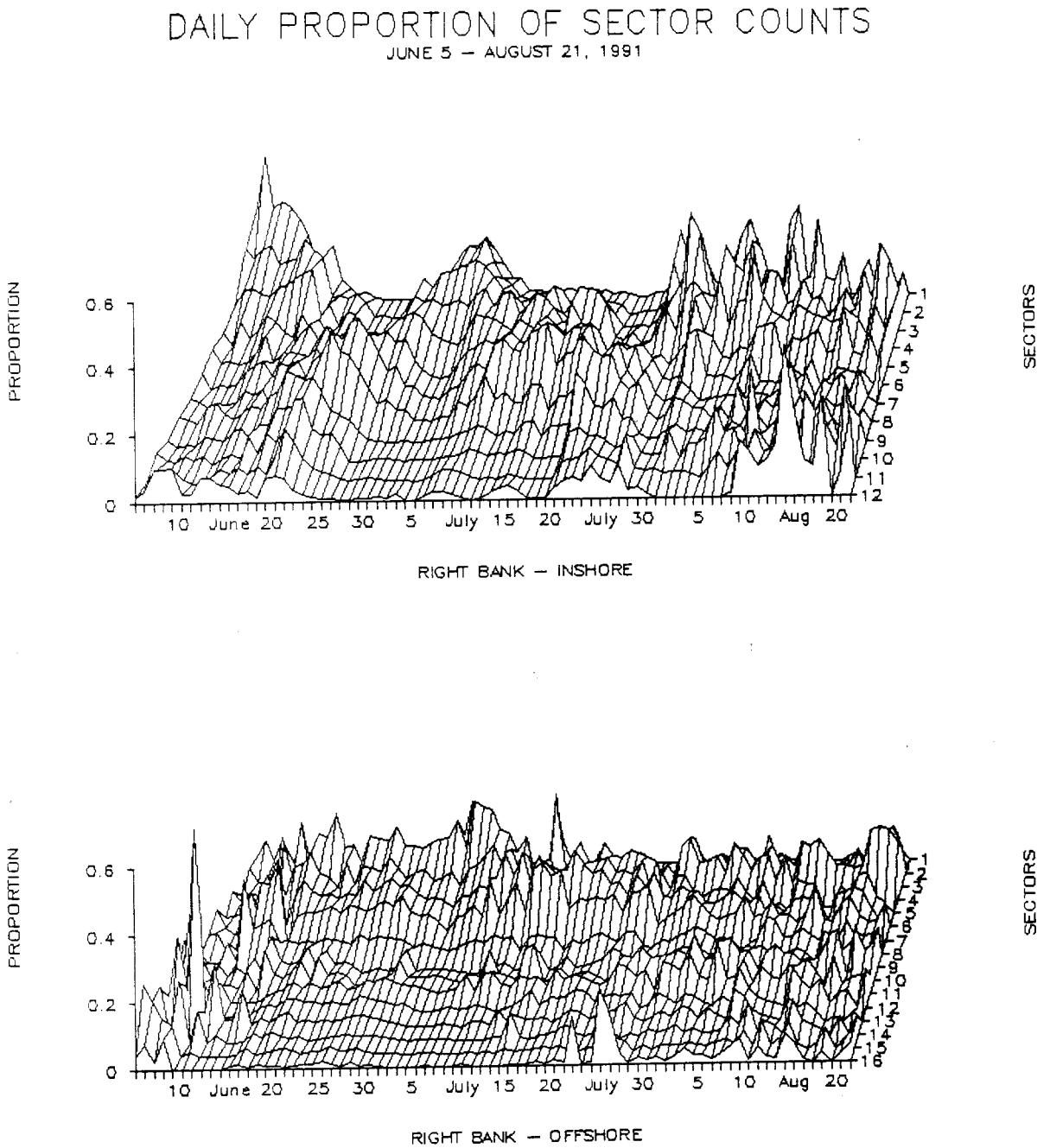

Figure 6. Daily proportion of sonar counts by sector, for the right bank, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

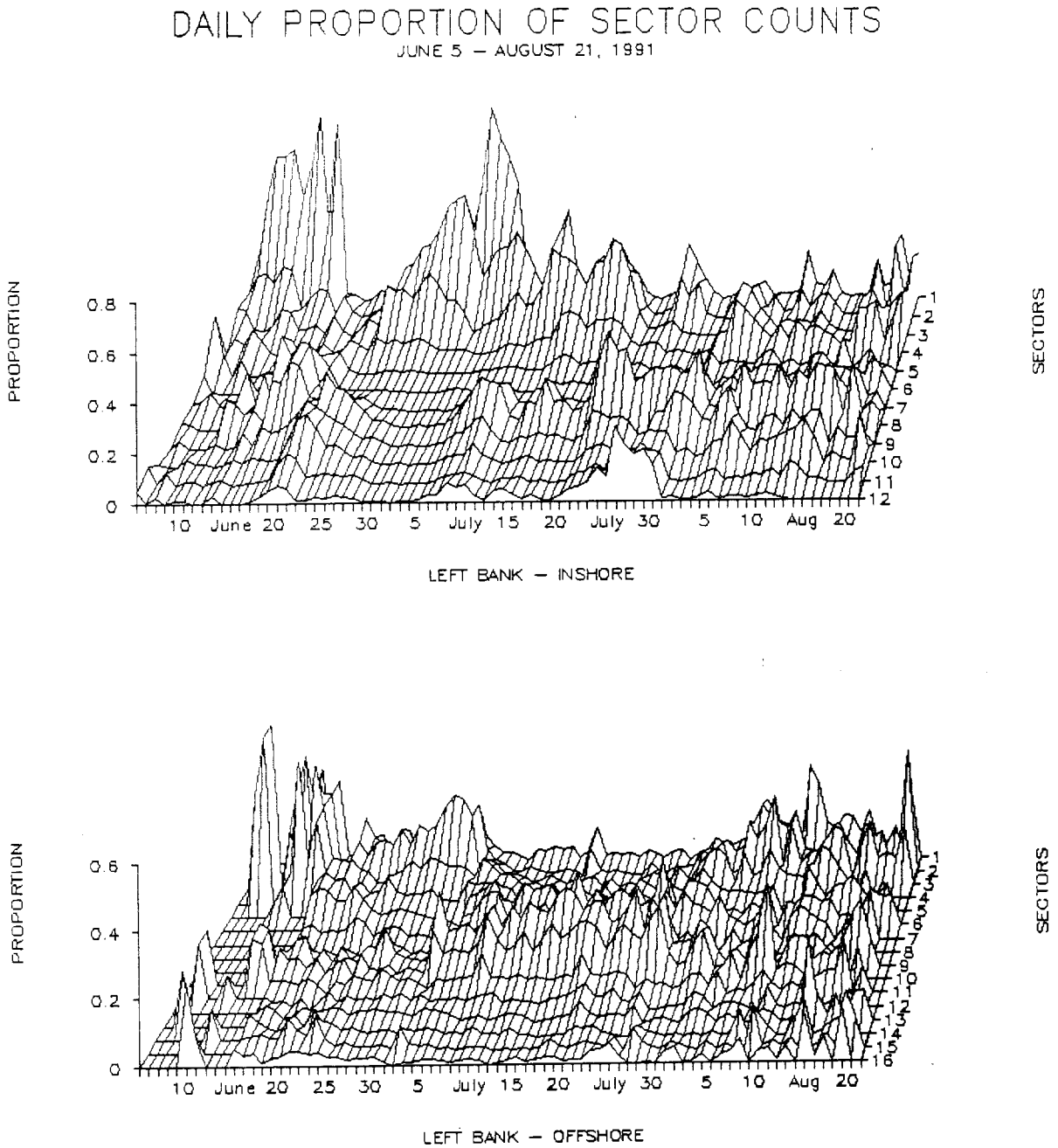

Figure 7. Daily proportion of sonar counts by sector, for the left bank, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

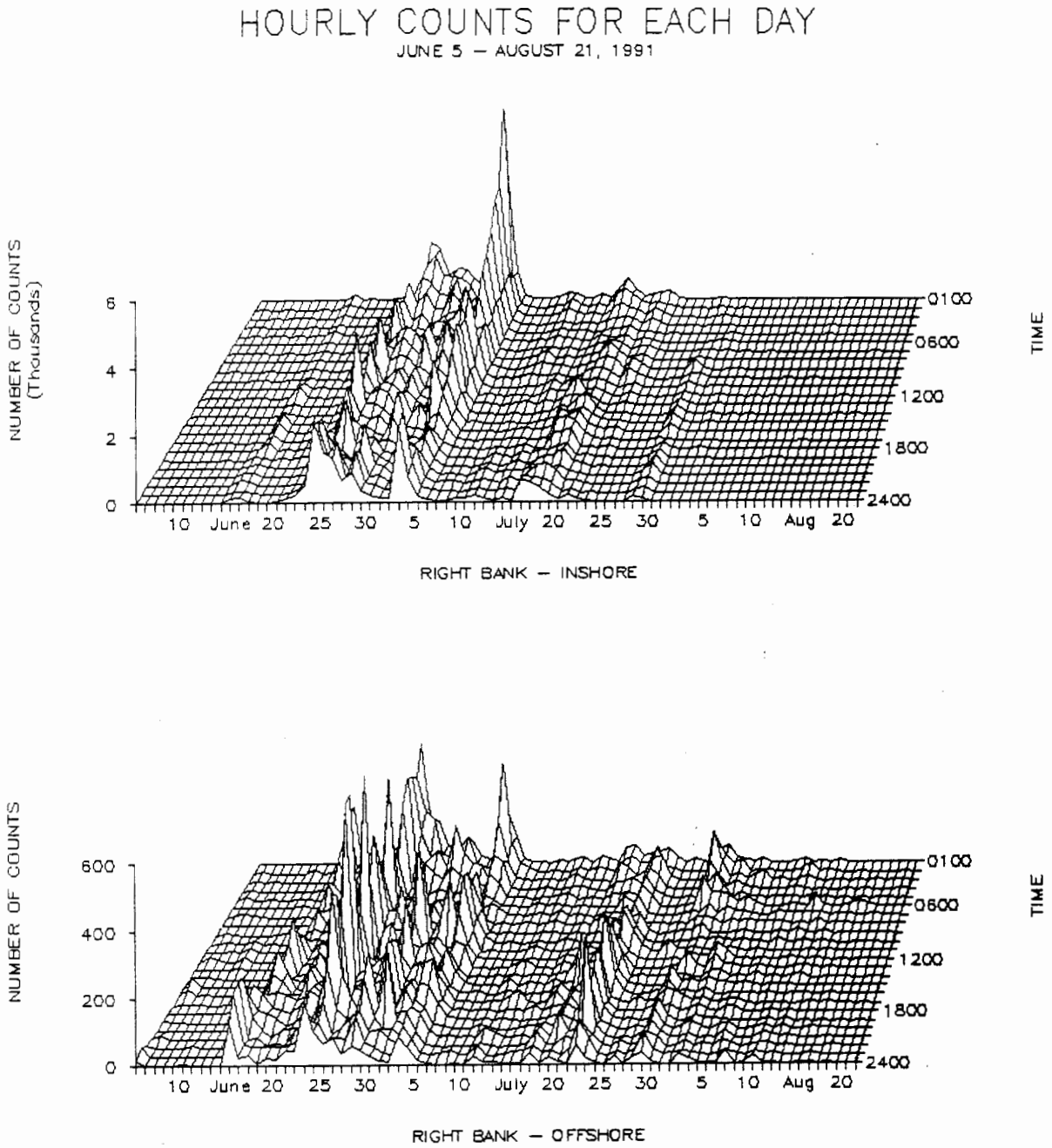

Figure 8. Number of sonar counts by hour for the right bank, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

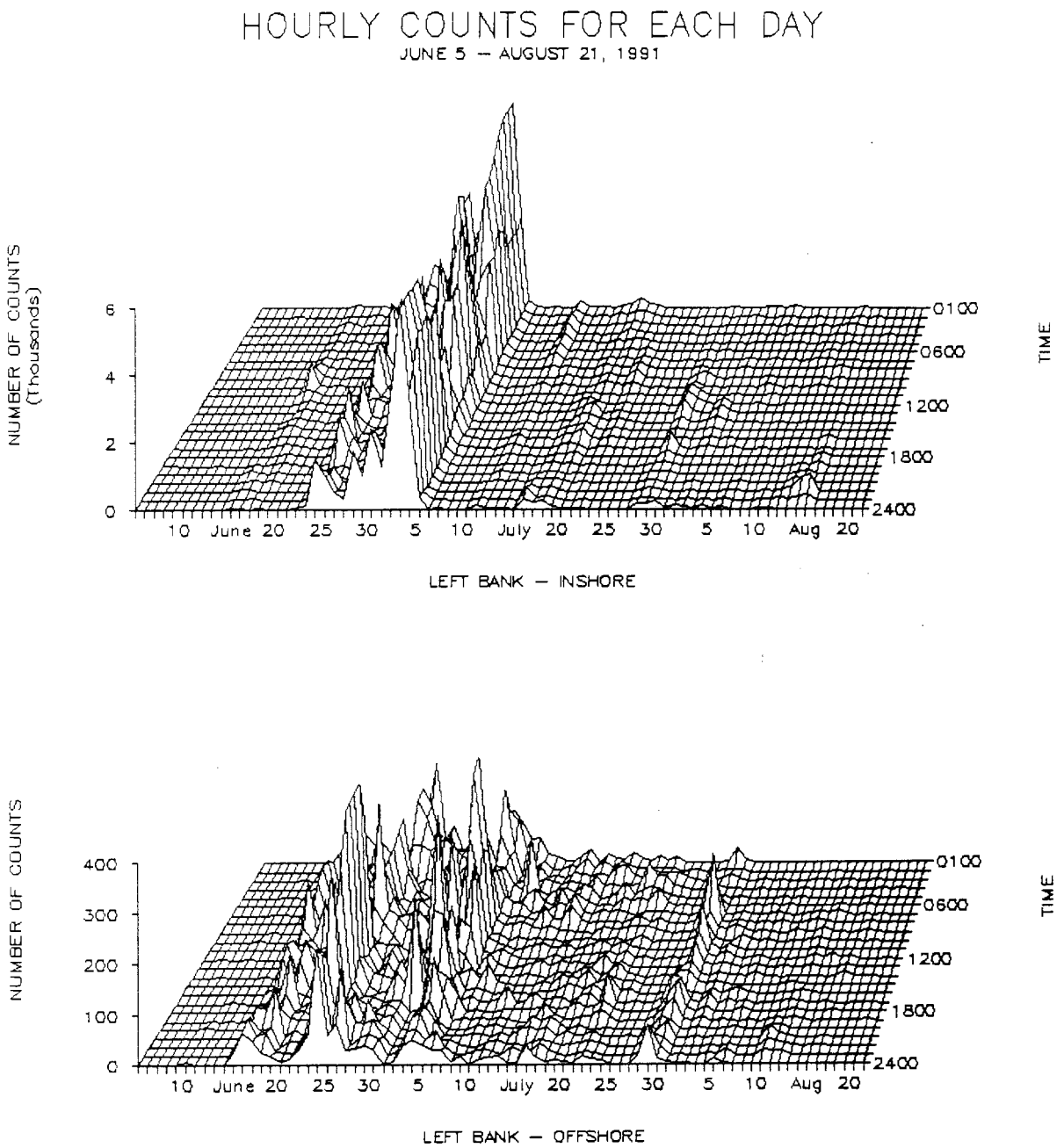

Figure 9. Number of sonar counts by hour, for the left bank, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

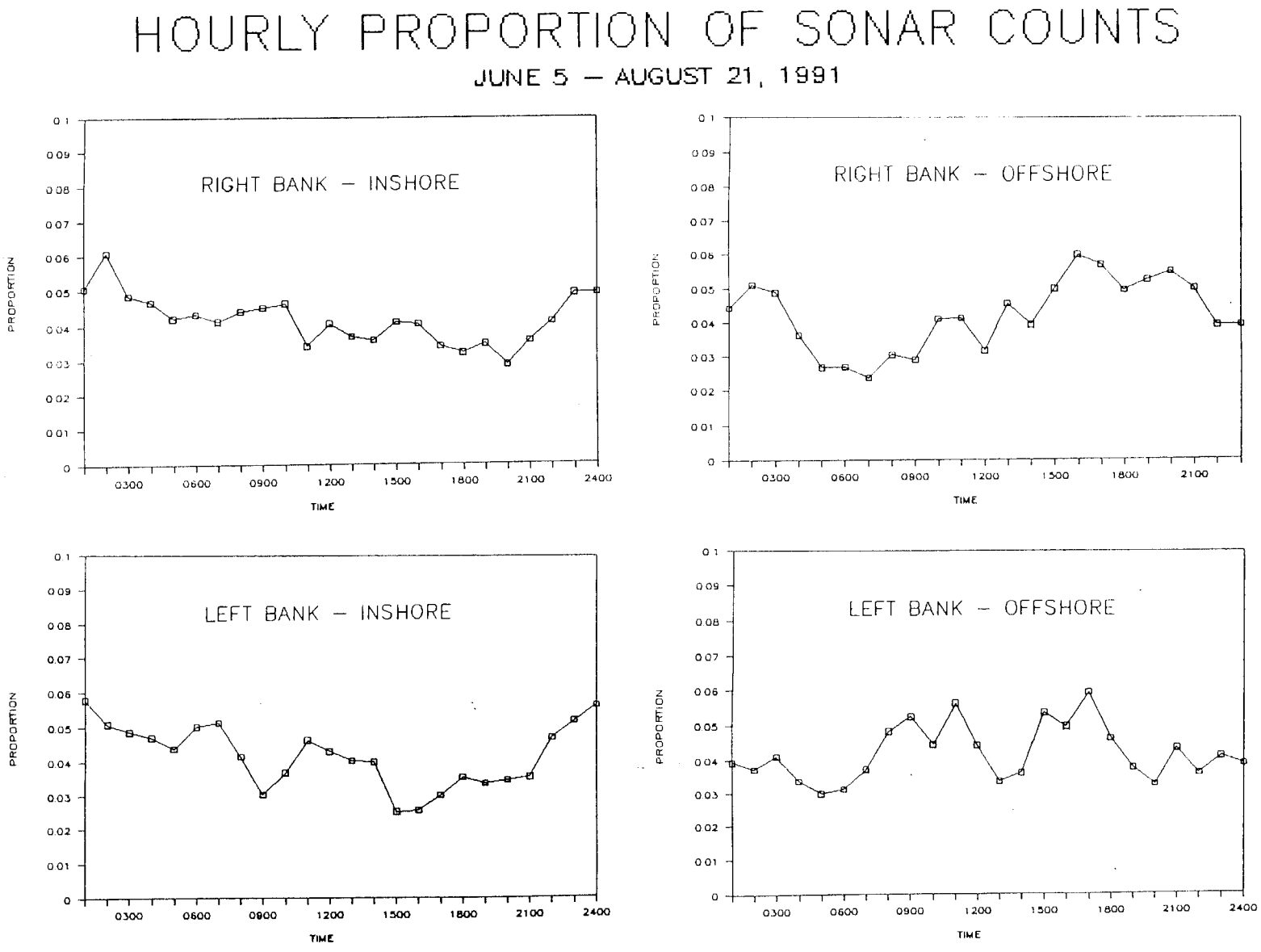

Figure 10. Proportion of sonar counts by hour for the right and left banks, inshore and offshore counters, on the Nushagak River, June 5 - August 21, 1991.

Appendix A.1. Beach seine and gill net catches by time-location strata, Nushagak River sonar, 1991.

Right Bank						Left Bank					
Inshore			Offshore			Inshore			Offshore		
Stratum Number	Dates	Catch[a]	Stratum Number	Dates	Catch[a]	Stratum Number	Dates	Catch[a]	Stratum Number	Dates	Catch[a]
1	6/05-6/14	3	1	6/05-6/14	1	1	6/05-6/14	1	1	6/05-6/14	0
2	6/15-6/20	36	2	6/15-6/20	13	2	6/15-6/20	46	2	6/15-6/20	22
3	6/21-6/23	48	3	6/21-6/28	85	3	6/21-6/24	60	3	6/21-6/28	61
4	6/24	(148)	4	6/29-7/05	87	4	6/25-6/27	82	4	6/29-7/05	45
5	6/25-6/26	56	5	7/06-7/14	39	5	6/28,6/30,7/02	52	5	7/06-7/16	24
6	6/27	40	6	7/15-7/20	11	6	6/29	(41)	6	7/17-8/01	22
7	6/28, 6/30-7/02	113	7	7/21-8/01	10	7	7/01	(130)	7	8/02-8/21	13
8	6/29	(45)	8	8/02-8/08	4	8	7/03	(213)			
9	7/03	(55)	9	8/09-8/13	9	9	7/04	(218)			
10	7/04-7/05	143	10	8/14-8/21	0	10	7/05	(107)			
11	7/06-7/14	112				11	7/06-7/16	99			
12	7/15-7/17	23				12	7/17-7/21	51			
13	7/18	(20)				13	7/22-7/26	17			
14	7/19	(44)				14	7/27-8/01	19			
15	7/20-7/26	40				15	8/02-8/08	31			
16	7/27-8/01	34				16	8/09-8/21	10			
17	8/02-8/08	39									
18	8/09-8/13	18									
19	8/14-8/21	0									

[a] Beach seine catch in parentheses.

Appendix B.1. Daily sonar counts, number of test fish sets, and number of fish caught, right bank - inshore, Nushagak River sonar, 1991.

Date	Sonar Counts	Number of Drifts and Seines[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
6/05	154	0	0	0	0	0	0	0
6/06	228	8	0	0	0	0	0	0
6/07	269	6	1	0	0	0	0	1
6/08	228	8	1	0	0	0	0	1
6/09	238	8	0	0	0	0	0	0
6/10	279	8	0	0	0	0	0	0
6/11	236	8	0	0	0	0	0	0
6/12	222	8	1	0	0	0	0	1
6/13	195	8	0	0	0	0	0	0
6/14	207	8	0	0	0	0	0	0
6/15	1,217	8	2	0	0	0	0	2
6/16	3,824	8	0	2	7	0	0	9
6/17	831	8	3	0	3	0	0	6
6/18	640	6	4	2	0	0	0	6
6/19	488	12	6	0	1	0	0	7
6/20	999	12	5	0	1	0	0	6
6/21	1,314	12	6	2	1	0	0	9
6/22	3,610	12	2	5	8	0	0	15
6/23	8,235	12	8	8	8	0	0	24
6/24	30,525	(6)	6	9	133	0	0	148
6/25	19,466	12	2	11	15	0	0	28
6/26	19,670	12	7	12	9	0	0	28
6/27	13,921	(4)	2	9	29	0	0	40
6/28	14,313	12	3	11	13	0	0	27
6/29	17,947	(4)	0	40	5	0	0	45
6/30	10,641	12	3	26	10	0	0	39
7/01	11,867	8	1	4	11	0	0	16
7/02	5,584	12	3	21	7	0	0	31
7/03	21,146	(2)	0	31	24	0	0	55
7/04	50,167	(4)	0	32	62	0	0	94
7/05	17,274	(2)	0	20	29	0	0	49
7/06	3,018	12	2	9	7	0	0	18
7/07	2,049	12	3	8	8	0	0	19
7/08	1,599	12	1	2	2	0	0	5
7/09	1,257	12	1	2	1	0	0	4
7/10	2,046	12	0	4	0	0	0	4
7/11	3,455	12	2	12	1	0	0	15
7/12	3,592	12	1	20	11	0	0	32
7/13	2,521	12	0	8	2	0	0	10
7/14	3,988	12	0	4	1	0	0	5

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Appendix B.1. (p 2 of 2)

Date	Sonar Counts	Number of Drifts and Seines[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
7/15	2,932	8	1	2	1	0	0	4
7/16	5,077	8	0	2	2	0	0	4
7/17	8,878	8	1	9	4	0	1	15
7/18	9,932	(2)	0	15	4	0	1	20
7/19	9,902	(4)	0	28	12	0	4	44
7/20	5,050	8	1	5	6	0	1	13
7/21	2,721	8	0	4	1	0	0	5
7/22	3,307	8	0	4	5	0	1	10
7/23	2,973	8	1	0	4	0	0	5
7/24	586	8	0	0	1	0	1	2
7/25	348	7	0	0	0	0	0	0
7/26	356	7	2	2	1	0	0	5
7/27	349	7	0	0	0	0	0	0
7/28	1,318	7	0	0	1	0	2	3
7/29	4,331	7	1	1	2	0	16	20
7/30	1,298	7	0	1	1	0	6	8
7/31	540	7	0	0	0	0	1	1
8/01	594	7	0	0	1	0	1	2
8/02	793	7	0	0	0	0	13	13
8/03	305	7	0	0	2	0	8	10
8/04	213	7	0	0	1	0	3	4
8/05	72	7	0	0	0	0	6	6
8/06	199	7	0	0	1	0	3	4
8/07	61	7	0	0	0	0	1	1
8/08	59	7	0	0	0	0	1	1
8/09	82	7	0	0	0	0	2	2
8/10	134	7	0	0	0	0	5	5
8/11	183	7	0	0	0	0	5	5
8/12	156	7	0	0	0	0	3	3
8/13	62	7	0	1	0	0	2	3
8/14	49	0	0	0	0	0	0	0
8/15	54	0	0	0	0	0	0	0
8/16	110	0	0	0	0	0	0	0
8/17	43	0	0	0	0	0	0	0
8/18	84	0	0	0	0	0	0	0
8/19	30	0	0	0	0	0	0	0
8/20	51	0	0	0	0	0	0	0
8/21	8	0	0	0	0	0	0	0
Total	342,700	540	83	388	459	0	87	1,017

[a] Beach seine sets in parentheses. Number of drifts represents gill net drifts conducted with 20.7 cm and 13.0 cm mesh nets.

Appendix B.2. Daily sonar counts, number of test fish sets, and number of fish caught, right bank - offshore, Nushagak River sonar, 1991.

Date	Sonar Counts	Number of Gill Net Drifts[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
6/05	73	0	0	0	0	0	0	0
6/06	155	8	0	0	0	0	0	0
6/07	43	6	1	0	0	0	0	1
6/08	30	8	0	0	0	0	0	0
6/09	5	8	0	0	0	0	0	0
6/10	72	8	0	0	0	0	0	0
6/11	10	8	0	0	0	0	0	0
6/12	36	8	0	0	0	0	0	0
6/13	31	8	0	0	0	0	0	0
6/14	17	8	0	0	0	0	0	0
6/15	1,197	8	1	0	0	0	0	1
6/16	1,862	8	3	0	2	0	0	5
6/17	670	8	0	0	0	0	0	0
6/18	641	6	0	0	0	0	0	0
6/19	358	12	0	2	0	0	0	2
6/20	878	12	4	1	0	0	0	5
6/21	1,052	12	1	1	1	0	0	3
6/22	923	12	2	2	4	0	0	8
6/23	1,592	12	6	3	4	0	0	13
6/24	7,660	10	6	9	8	0	0	23
6/25	1,741	12	3	5	3	0	0	11
6/26	1,904	12	5	2	0	0	0	7
6/27	1,407	12	2	1	3	0	0	6
6/28	1,472	12	3	3	8	0	0	14
6/29	2,562	12	6	6	11	0	0	23
6/30	1,172	12	3	6	5	0	0	14
7/01	1,064	12	5	1	5	0	0	11
7/02	587	12	2	3	7	0	0	12
7/03	1,159	12	2	1	2	0	0	5
7/04	2,824	12	6	0	7	0	0	13
7/05	1,132	12	5	1	3	0	0	9
7/06	270	12	3	8	3	0	0	14
7/07	197	12	1	1	2	0	0	4
7/08	153	12	3	3	1	0	0	7
7/09	118	12	1	0	0	0	0	1
7/10	193	12	2	1	0	0	0	3
7/11	275	12	0	2	1	0	0	3
7/12	242	12	2	1	0	0	0	3
7/13	267	12	0	0	0	0	0	0
7/14	139	12	2	1	1	0	0	4

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Appendix B.2. (p 2 of 2)

Date	Sonar Counts	Number of Gill Net Drifts[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
7/15	200	8	1	2	0	0	0	3
7/16	255	8	2	1	1	0	0	4
7/17	508	8	0	1	0	0	0	1
7/18	416	8	0	0	0	0	0	0
7/19	829	8	1	0	1	0	0	2
7/20	570	8	0	1	0	0	0	1
7/21	573	8	0	1	0	0	0	1
7/22	2,713	8	0	0	0	0	0	0
7/23	986	8	0	0	0	0	0	0
7/24	254	8	0	0	0	0	0	0
7/25	86	7	0	0	0	0	0	0
7/26	175	7	0	0	2	0	1	3
7/27	152	7	0	0	0	0	0	0
7/28	239	7	0	0	0	0	0	0
7/29	1,124	7	0	0	0	0	0	0
7/30	760	7	0	0	0	0	2	2
7/31	325	7	0	0	0	0	0	0
8/01	302	7	0	0	0	0	4	4
8/02	470	7	0	0	0	0	0	0
8/03	323	7	0	0	0	0	3	3
8/04	205	7	0	0	0	0	0	0
8/05	145	7	0	0	0	0	1	1
8/06	219	7	0	0	0	0	0	0
8/07	184	7	0	0	0	0	0	0
8/08	144	7	0	0	0	0	0	0
8/09	136	7	0	0	0	0	0	0
8/10	199	7	1	0	0	0	4	5
8/11	181	7	0	0	0	0	4	4
8/12	158	7	0	0	0	0	0	0
8/13	80	7	0	0	0	0	0	0
8/14	46	0	0	0	0	0	0	0
8/15	82	0	0	0	0	0	0	0
8/16	100	0	0	0	0	0	0	0
8/17	58	0	0	0	0	0	0	0
8/18	65	0	0	0	0	0	0	0
8/19	18	0	0	0	0	0	0	0
8/20	33	0	0	0	0	0	0	0
8/21	17	0	0	0	0	0	0	0
Total	49,513	630	85	70	85	0	19	259

[a] Number of drifts represents gill net drifts conducted with 20.7 cm and 13.0 cm mesh nets.

Appendix B.3. Daily sonar counts, number of test fish sets, and number of fish caught, left bank - inshore, Nushagak River sonar, 1991.

Date	Sonar Counts	Number of Drifts and Seines[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
6/05	63	0	0	0	0	0	0	0
6/06	89	8	0	0	0	0	0	0
6/07	38	6	0	0	0	0	0	0
6/08	62	8	1	0	0	0	0	1
6/09	69	8	0	0	0	0	0	0
6/10	65	8	0	0	0	0	0	0
6/11	85	8	0	0	0	0	0	0
6/12	121	8	0	0	0	0	0	0
6/13	96	8	0	0	0	0	0	0
6/14	75	8	0	0	0	0	0	0
6/15	666	8	3	0	0	0	0	3
6/16	3,104	8	12	0	4	0	0	16
6/17	1,965	8	4	0	1	0	0	5
6/18	1,435	6	8	0	0	0	0	8
6/19	1,017	12	10	0	0	0	0	10
6/20	417	12	3	0	1	0	0	4
6/21	459	12	3	3	1	0	0	7
6/22	583	12	7	2	2	0	0	11
6/23	1,636	12	12	3	1	0	0	16
6/24	22,791	5	22	2	2	0	0	26
6/25	12,167	12	18	7	11	0	0	36
6/26	8,208	12	12	2	2	0	0	16
6/27	6,290	12	13	9	8	0	0	30
6/28	11,067	12	4	3	3	0	0	10
6/29	38,406	(4)	1	40	0	0	0	41
6/30	19,734	12	6	10	7	0	0	23
7/01	55,434	(6)	1	126	3	0	0	130
7/02	28,740	12	5	13	1	0	0	19
7/03	87,330	(8)	0	194	19	0	0	213
7/04	104,609	(7)	1	163	54	0	0	218
7/05	34,555	(4)	1	86	20	0	0	107
7/06	3,160	12	9	6	1	0	0	16
7/07	1,223	12	2	7	3	0	0	12
7/08	758	12	6	1	1	0	0	8
7/09	652	12	4	1	0	0	0	5
7/10	609	12	2	3	2	0	0	7
7/11	1,531	12	2	6	0	0	0	8
7/12	3,816	12	2	14	1	0	0	17
7/13	1,219	12	0	4	1	0	0	5
7/14	1,542	12	0	6	2	0	0	8

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Appendix B.3. (p 2 of 2)

Date	Sonar Counts	Number of Drifts and Seines[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
7/15	1,009	8	4	3	2	0	0	9
7/16	1,767	8	4	0	0	0	0	4
7/17	2,454	8	3	7	2	0	0	12
7/18	3,566	8	0	7	3	0	0	10
7/19	3,913	8	2	8	4	0	1	15
7/20	1,988	8	0	2	3	0	0	5
7/21	1,440	8	4	3	1	0	1	9
7/22	2,125	8	0	1	9	0	0	10
7/23	1,067	8	0	1	3	0	0	4
7/24	301	8	1	0	1	0	0	2
7/25	211	7	0	0	0	0	0	0
7/26	157	7	0	1	0	0	0	1
7/27	222	7	0	0	0	0	0	0
7/28	888	7	0	0	2	0	3	5
7/29	3,906	7	0	0	1	0	4	5
7/30	1,607	7	0	0	0	0	3	3
7/31	634	7	0	0	0	0	6	6
8/01	666	7	0	0	0	0	0	0
8/02	1,905	7	0	0	0	0	4	4
8/03	817	7	0	0	1	0	3	4
8/04	747	7	0	0	1	0	6	7
8/05	535	7	0	0	0	0	8	8
8/06	1,068	7	0	0	2	0	6	8
8/07	627	7	0	0	0	0	0	0
8/08	269	7	0	0	0	0	0	0
8/09	366	7	0	0	0	0	0	0
8/10	358	7	0	0	0	0	2	2
8/11	432	7	0	0	0	0	5	5
8/12	826	7	0	0	0	0	0	0
8/13	895	7	0	0	0	0	3	3
8/14	1,395	0	0	0	0	0	0	0
8/15	1,458	0	0	0	0	0	0	0
8/16	111	0	0	0	0	0	0	0
8/17	39	0	0	0	0	0	0	0
8/18	100	0	0	0	0	0	0	0
8/19	68	0	0	0	0	0	0	0
8/20	49	0	0	0	0	0	0	0
8/21	17	0	0	0	0	0	0	0
Total	495,889	565	192	744	186	0	55	1,177

[a] Beach seine sets in parentheses. Number of drifts represents gill net drifts conducted with 20.7 cm and 13.0 cm mesh nets.

Appendix B.4. Daily sonar counts, number of test fish sets, and number of fish caught, left bank - offshore, Nushagak River sonar, 1991.

Date	Sonar Counts	Number of Gill Net Drifts[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
6/05	0	0	0	0	0	0	0	0
6/06	1	6	0	0	0	0	0	0
6/07	6	6	0	0	0	0	0	0
6/08	2	8	0	0	0	0	0	0
6/09	2	8	0	0	0	0	0	0
6/10	27	8	0	0	0	0	0	0
6/11	11	8	0	0	0	0	0	0
6/12	7	8	0	0	0	0	0	0
6/13	8	8	0	0	0	0	0	0
6/14	4	8	0	0	0	0	0	0
6/15	211	8	1	0	0	0	0	1
6/16	1,675	8	5	0	2	0	0	7
6/17	872	8	2	0	0	0	0	2
6/18	1,086	6	4	0	0	0	0	4
6/19	408	12	3	0	0	0	0	3
6/20	247	12	5	0	0	0	0	5
6/21	391	12	5	1	0	0	0	6
6/22	388	12	3	1	3	0	0	7
6/23	502	12	0	1	0	0	0	1
6/24	5,642	10	15	5	2	0	0	22
6/25	1,884	12	2	0	3	0	0	5
6/26	1,382	12	4	0	1	0	0	5
6/27	952	12	5	0	0	0	0	5
6/28	850	12	7	1	2	0	0	10
6/29	1,103	12	7	1	7	0	0	15
6/30	745	12	1	3	1	0	0	5
7/01	1,940	12	3	1	1	0	0	5
7/02	1,323	12	3	3	2	0	0	8
7/03	1,085	12	0	1	0	0	0	1
7/04	2,824	12	5	0	1	0	0	6
7/05	1,755	13	5	0	0	0	0	5
7/06	519	12	6	1	0	0	0	7
7/07	368	12	4	1	0	0	0	5
7/08	397	12	1	0	2	0	0	3
7/09	222	12	3	0	0	0	0	3
7/10	143	12	0	1	0	0	0	1
7/11	244	12	0	0	0	0	0	0
7/12	269	12	0	0	0	0	0	0
7/13	211	12	3	0	0	0	0	3
7/14	271	12	2	0	0	0	0	2

-Continued-

Appendix B.4. (p 2 of 2)

Date	Sonar Counts	Number of Gill Net Drifts[a]	Catch by Species					
			Chinook	Sockeye	Chum	Pink	Coho	Total
7/15	269	8	0	0	0	0	0	0
7/16	241	8	0	0	0	0	0	0
7/17	320	8	1	0	0	0	0	1
7/18	256	8	4	0	2	0	1	7
7/19	290	8	1	0	0	0	0	1
7/20	214	8	0	0	0	0	0	0
7/21	274	8	1	0	0	0	0	1
7/22	417	8	0	0	1	0	0	1
7/23	238	8	0	0	1	0	0	1
7/24	124	8	1	0	0	0	0	1
7/25	48	7	1	0	0	0	0	1
7/26	36	7	2	0	0	0	0	2
7/27	29	7	0	0	0	0	0	0
7/28	133	7	0	0	0	0	1	1
7/29	603	7	0	0	0	0	3	3
7/30	878	7	0	0	0	0	0	0
7/31	135	7	0	0	0	0	0	0
8/01	56	7	1	0	0	0	1	2
8/02	175	7	0	0	0	0	1	1
8/03	77	7	0	0	0	0	0	0
8/04	68	7	0	0	0	0	1	1
8/05	69	7	0	0	0	0	1	1
8/06	96	7	0	0	0	0	2	2
8/07	27	7	0	0	0	0	0	0
8/08	14	7	0	0	0	0	0	0
8/09	27	7	0	0	0	0	0	0
8/10	103	7	0	0	0	0	2	2
8/11	105	7	0	0	0	0	5	5
8/12	110	7	0	0	0	0	1	1
8/13	58	7	0	0	0	0	0	0
8/14	36	0	0	0	0	0	0	0
8/15	24	0	0	0	0	0	0	0
8/16	56	0	0	0	0	0	0	0
8/17	24	0	0	0	0	0	0	0
8/18	19	0	0	0	0	0	0	0
8/19	12	0	0	0	0	0	0	0
8/20	11	0	0	0	0	0	0	0
8/21	1	0	0	0	0	0	0	0
Total	35,650	629	116	21	31	0	19	187

[a] Number of drifts represents gill net drifts conducted with 20.7 cm and 13.0 cm mesh nets.

Appendix C.1. Climatological observations, Nushagak River sonar, 1991.

Date	Cloud Cover[a] 0800	Cloud Cover[a] 2000	Wind Velocity (k/hr) 0800	Wind Velocity (k/hr) 2000	Air Temp. (°C) 0800	Air Temp. (°C) 2000	Water Temp. (°C) 0800	Water Temp. (°C) 2000	Precip. (mm)	Water Color
6 05	3	4	0-5 NW	0-5 NW	4.5	10.0	7.0	8.5	19	-
6 06	3	2	calm	5-10 S	8.5	11.5	8.0	9.0	4	brown
6 07	3	3	0-5 SE	5 SE	9.0	12.0	8.0	10.0	trace	brown
6 08	3	2	5 SE	5-10 SE	6.0	14.5	9.0	11.0	0.5	brown
6 09	2	1	5-10 NNE	0-5 E	7.5	16.0	10.5	11.5	0	brown
6 10	2	3	0-5 S	5-10 S	16.0	10.0	11.0	13.0	0	brown
6 11	4	4	0-5 S	5-10 SW	7.0	11.0	11.0	12.5	0	lt brown
6 12	5	1	variable	0-5 SW	7.5	15.5	12.0	13.5	0	lt brown
6 13	1	2	0-3 E	0-5 SW	20.0	16.5	13.0	13.5	10	lt brown
6 14	1	2	0-5 W	10-15 W	16.0	13.5	13.0	13.0	0	lt brown
6 15	3	4	0-5 W	15-20 SW	16.5	9.0	12.0	13.0	0	lt brown
6 16	4	4	5-10 S	5-10 SW	7.5	9.0	12.0	12.0	4	brown
6 17	4	4	5-10 SE	10-15 S	8.0	10.5	11.5	11.0	6	dk brown
6 18	3	0	variable	0	8.0	-	10.5	-	-	brown
6 19	4	4	10-15 SE	calm	10.0	16.0	9.0	12.0	3	brown
6 20	3	3	5-10 SE	0-5 E	13.0	13.0	10.0	11.0	2	brown
6 21	1	2	variable	0-5 S	9.0	10.0	10.5	12.0	0.5	brown
6 22	3	4	0-5 E	15-20 SE	11.5	12.0	11.5	11.5	0	brown
6 23	4	4	5-10 SE	variable	11.0	13.5	11.0	13.5	15	brown
6 24	4	4	0-5 E	0-5 E	-	12.0	-	13.0	7	brown
6 25	4	4	variable	variable	13.0	12.0	11.5	11.0	8	brown
6 26	4	4	calm	0-5 SE	14.0	13.0	12.0	12.0	12	brown
6 27	4	3	0-5 W	0-5 NW	12.0	16.0	11.5	13.5	4	brown
6 28	5	3	-	0-5 S	-	14.0	-	14.0	6	brown
6 29	5	2	variable	0-5 SE	14.0	24.0	13.0	16.0	0.5	brown
6 30	5	3	0-5 S	5-10 SW	12.0	16.0	14.0	16.0	-	brown
7 01	5	1	0-5 SE	5-10 S	14.0	19.0	14.0	18.0	0.5	brown
7 02	5	3	0-5 ESE	0-5 S	11.0	-	14.0	-	0	brown
7 03	-	1	-	variable	-	17.8	-	18.5	0	brown
7 04	4	2	variable	-	14.0	29.0	16.0	17.0	0	brown
7 05	3	4	5-10 SSE	0-5 S	-	14.0	16.5	16.0	13	brown
7 06	4	2	0-5 SSE	variable	15.0	-	15.0	-	0	brown
7 07	3	3	0-5 NE	0-5 W	16.0	18.0	16.0	16.0	0	brown
7 08	2	2	0-5 W	5-10 WNW	16.0	21.0	16.0	16.0	0	lt brown
7 09	2	3	variable	5-10 SE	15.0	18.0	15.0	16.0	3	lt brown
7 10	5	1	calm	5-10 SW	13.0	21.0	16.0	18.0	10	lt brown
7 11	5	1	10-15 SE	10 S	-	18.0	-	16.0	0	lt brown
7 12	4	2	calm	5-10 SW	14.0	18.0	15.0	16.0	0	lt brown
7 13	5	3	5-10 SE	5-10 SE	12.0	15.0	14.0	15.0	trace	lt brown
7 14	3	3	0-5 S	0-5 S	10.0	15.0	14.5	14.5	trace	lt brown
7 15	4	4	10-15 SE	8-10 S	12.0	11.0	14.0	13.0	3	lt brown
7 16	4	4	20-25 SSE	15-18 SW	9.0	9.0	13.0	12.0	11	lt brown
7 17	4	3	variable	15-20 WSW	9.5	13.0	11.0	13.0	0.5	lt brown
7 18	4	-	-	-	-	-	-	-	-	lt brown
7 19	4	4	0-5 SW	5-6 SW	10.5	10.5	12.0	14.0	15	lt brown
7 20	4	2	0-5 SW	0-3 SW	11.0	12.0	12.5	14.0	trace	lt brown
7 21	5	1	calm	5 NW	8.0	22.0	12.5	15.5	-	lt brown
7 22	1	2	calm	variable	10.0	23.0	14.0	16.0	-	lt brown
7 23	2	3	1-2	5-10 E	11.0	18.0	15.5	16.5	trace	lt brown
7 24	1	3	1-2	0-5 E	12.0	10.5	15.0	16.0	-	lt brown
7 25	2	1	calm	5 N	9.5	17.5	15.0	16.0	-	lt brown

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Appendix C.1. (p 2 of 2)

Date	Cloud Cover[a] 0800	Cloud Cover[a] 2000	Wind Velocity (h/hr) 0800	Wind Velocity (h/hr) 2000	Air Temp. (°C) 0800	Air Temp. (°C) 2000	Water Temp. (°C) 0800	Water Temp. (°C) 2000	Precip. (mm)	Water Color
7 26	5	1	calm	5-10 SSW	9.5	16.0	15.0	16.5	-	lt brown
7 27	5	-	5-10 SSW	-	13.0	-	15.0	-	-	lt brown
7 28	3	-	5-10 SE	-	12.0	-	14.0	-	0	lt brown
7 29	-	4	-	5-10 S	-	14.0	-	14.0	1	lt brown
7 30	4	4	calm	0-5 W	12.5	12.0	14.0	15.0	4	lt brown
7 31	1	2	5 NW	5-10 SW	10.0	11.5	12.5	13.5	1	lt brown
8 01	1	3	5-10 W	5-10 SW	10.0	11.0	12.5	12.0	trace	lt brown
8 02	3	1	5 SE	calm	11.0	16.0	13.0	13.0	-	lt brown
8 03	3	2	5 NW	-	10.0	-	13.0	-	-	lt brown
8 04	4	1	-	calm	-	17.0	14.0	16.0	trace	lt brown
8 05	1	3	0-5 SW	5-10 S	9.0	18.5	13.5	15.5	-	lt brown
8 06	4	2	calm	5 NW	12.0	19.0	15.0	16.0	-	lt brown
8 07	4	3	0-5 SW	8-9 SW	10.0	15.0	15.5	15.0	-	lt brown
8 08	4	4	5-7 S	7-9 S	10.5	12.0	15.0	14.0	0.5	lt brown
8 09	4	4	0-5 NNE	-	10.0	-	14.5	-	-	lt brown
8 10	3	3	5-7 ESE	10-13 S	11.0	14.5	14.0	14.0	1	lt brown
8 11	4	4	0-5 NE	5-7 S	12.0	14.5	14.0	15.0	8	lt brown
8 12	4	-	calm	-	11.5	-	14.0	-	0.5	lt brown
8 13	4	-	calm	-	11.0	-	13.5	-	3	lt brown
8 14	3	4	0-5 NE	0-5 SE	-	12.0	13.0	12.0	8	lt brown
8 15	4	4	0-5 NE	5-10 S	10.0	14.0	12.0	13.0	8	lt brown
8 16	4	-	0-5 ENE	-	15.0	-	13.0	-	trace	lt brown
8 17	4	3	calm	5 S	13.0	13.0	13.0	13.0	8	lt brown
8 18	1	4	calm	calm	15.0	15.0	12.0	13.0	4	lt brown
8 19	4	4	calm	calm	12.0	17.0	13.0	13.0	3	lt brown
8 20	5	-	0-5 W	5-10 SW	13.0	13.0	14.0	14.0	trace	lt brown
8 21	5	-	calm	-	13.0	-	14.0	-	trace	lt brown

[a]1 = clouds covering less than 1/10 of sky
2 = not more than 1/2
3 = more than 1/2
4 = completely overcast
5 = fog or thick haze

Appendix D.1 Daily chinook salmon escapement estimates and average run proportions, Nushagak River sonar, 1980 - 1991.

												Average Proportion[a]	
Date	1980	1981	1982	1983	1985	1986	1987	1988	1989	1990	1991	Daily	Cumulative
6 05											290	0.03	0.03
6 06						1	45		2	63	473	0.63	0.09
6 07						9	153	115	4	64	356	0.10	0.19
6 08						6	158	165	3	136	322	0.12	0.31
6 09						11	1,676	336	14	386	314	0.43	0.74
6 10					0	51	1,441	916	19	151	443	0.50	1.24
6 11				118	44	41	640	873	9	108	342	0.37	1.61
6 12		1,128		156	9	82	760	186	23	94	386	0.25	1.87
6 13		2,124		212	112	318	446	205	25	241	330	0.32	2.19
6 14		1,951	281	131	148	297	507	143	23	166	303	0.29	2.48
6 15		1,500	589	204	33	101	657	1,875	25	2,468	2,184	1.26	3.74
6 16		2,660	557	139	24	148	366	5,078	24	1,953	7,492	2.31	6.05
6 17		909	1,432	132	14	43	2,048	1,359	138	844	3,375	1.13	7.18
6 18		584	1,583	143	20	72	2,943	874	188	712	2,985	1.11	8.30
6 19		568	1,123	136	371	424	1,407	570	64	788	1,747	0.85	9.14
6 20		14	790	368	2,627	789	883	1,084	109	542	1,682	1.25	10.39
6 21		56	7,836	570	3,886	525	678	613	450	1,374	1,384	1.41	11.81
6 22	3,975	2,056	5,746	3,180	1,755	521	724	449	1,746	10,709	2,196	3.54	15.34
6 23	5,377	3,556	6,791	1,553	3,557	188	611	781	2,712	4,692	4,807	2.75	18.09
6 24	1,463	7,500	17,239	5,124	888	274	14,082	1,279	5,876	1,729	24,266	6.70	24.79
6 25	2,040	11,472	4,179	2,715	380	516	10,196	6,334	2,561	890	11,349	5.06	29.85
6 26	3,707	7,049	2,612	4,388	645	643	2,340	4,292	5,973	285	9,022	3.93	33.78
6 27	4,623	5,592	1,567	4,828	1,761	999	1,296	2,481	1,257	313	5,098	2.56	33.34
6 28	3,661	1,625	1,567	11,618	1,716	750	2,215	1,980	838	264	5,515	3.29	39.63
6 29	1,524	3,140	3,134	5,649	604	405	5,444	2,486	2,167	332	2,379	2.86	42.49
6 30	1,553	3,909	5,224	8,468	907	443	2,179	1,007	1,521	283	7,422	2.79	45.28
7 01	1,875	2,432	5,746	5,742	9,184	128	7,369	536	395	1,428	2,866	3.71	48.99
7 02	4,688	21,917	5,746	5,556	15,016	181	1,612	700	417	5,317	9,686	5.01	54.00
7 03	2,702	14,789	5,224	2,880	6,527	187	3,448	1,612	6	2,350	965	2.64	56.64
7 04	2,777	10,517	1,045	4,866	4,291	82	1,581	3,519	1,386	1,857	2,927	3.01	59.65
7 05	2,850	5,773	4,179	4,876	4,074	782	781	3,339	2,614	724	1,636	3.89	62.54
7 06	2,252	3,400	4,179	1,769	5,850	1,249	399	625	2,812	1,171	1,984	2.36	64.90
7 07	2,052	2,214	3,657	1,342	4,023	2,256	565	684	3,861	2,579	977	2.76	67.66
7 08	602	1,028	1,567	1,482	3,217	1,990	1,922	705	2,817	10,211	780	4.12	71.78
7 09	285	1,720	2,090	1,168	2,752	2,192	1,508	0	1,104	2,301	561	2.02	73.80

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Appendix D.1 (p 2 of 3)

Date	1980	1981	1982	1983	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a] Daily	Average Proportion[a] Cumulative
7 10	784	1,880	3,134	981	2,886	1,843	235	0	1,905	1,636	580	1.73	75.53
7 11	1,284	1,880	1,567	2,351	2,192	1,111	462	0	1,059	433	1,142	1.31	76.83
7 12	917	2,049	2,612	2,347	1,222	3,891	641	2,663	6,996	643	1,970	3.66	80.50
7 13	1,010	1,103	2,090	1,794	829	1,247	502	509	2,408	619	909	1.46	81.95
7 14	1,108	959	2,090	2,345	1,880	1,447	407	724	1,591	447	1,166	1.61	83.56
7 15	624	934	4,702	2,440	4,016	3,045	1,074	296	2,527	179	897	2.42	85.98
7 16	662	264	1,567	755	2,000	1,166	937	307	2,070	157	1,350	1.37	87.35
7 17	2,689		2,090	387	1,718	3,097	890	653	2,186	281	1,564	1.98	89.33
7 18	5,101		2,090	435	1,631	1,146	1,069	648	3,628	243	920	1.60	90.93
7 19	595		522	422	2,389	1,176	947	282	1,420	25	1,150	1.23	92.16
7 20	0		1,045	456	951	936	743	529	1,828	30	1,180	1.08	93.24
7 21	0		522	361	493	738	1,399	788	1,619	51	676	1.03	94.27
7 22	0		1,567	373	477	398	509	766	795	114	683	0.68	94.65
7 23	0		522	435	371	288	224	89	728	127	490	0.42	95.37
7 24	0		1,045	458	119	808	269	102	1,106	131	144	0.58	95.95
7 25	0		1,500	566	522	463	168	229	748	364	73	0.54	96.49
7 26	0		2,090	597	319	61	157	91	452	208	64	0.45	96.94
7 27	0		0	592	234	1,168	158	78	317	94	26	0.55	97.49
7 28	0		0	633	104	120	90	111	372	531	111	0.34	97.82
7 29	0		0	644	29	0	68	79	327	37	456	0.21	98.03
7 30	0		0	413	17	182	77	142	517	22	517	0.28	98.32
7 31	0		0	957	27	60	51	87	1,098	12	90	0.35	98.65
8 01	0		0	660	26	50	44	95	474	0	48	0.20	98.87
8 02	0		0	790	18	0	61	0	205	46	0	0.15	99.02
8 03	0		0	734	24	0	47	436	362	0	0	0.25	99.27
8 04	0		0	658	62	787	0	0	170	0	0	0.34	99.61
8 05	0		0	55	0	381	0	0	59	0	0	0.13	99.74
8 06	0		0	89	0	204	0	0	57	0	0	0.79	99.81
8 07			0	83	0	87	0	0	95	0	0	0.05	99.86
8 08			0	211	0	72	0	0	0	0	0	0.05	99.91
8 09			0	232	0	66	0	0	0	0	15	0.05	99.96
8 10			0	0	0	135	0	0	0	0	22	0.04	100.00
8 11			0	0	0	0	0	0	0	0	20		
8 12			0	0	0	0	0	0	0	0	18		
8 13			0	0	0	0	0	0	0	0	9		
8 14			0	0	0	0	0	0	0	0	0		
8 15			0	0	0	0	0	0	0	0	0		

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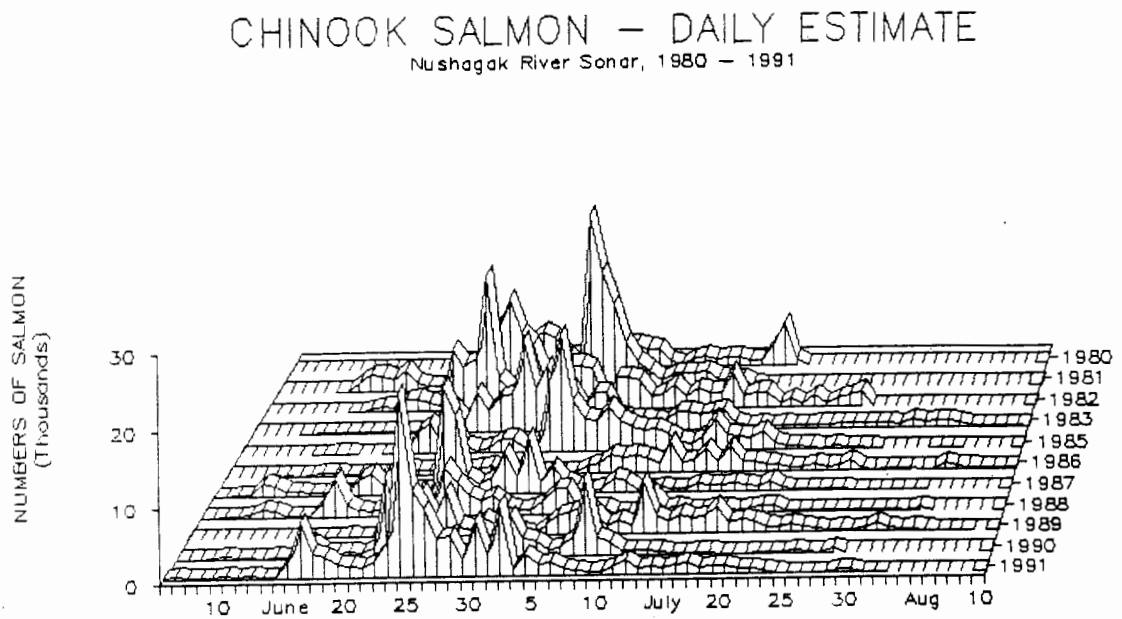
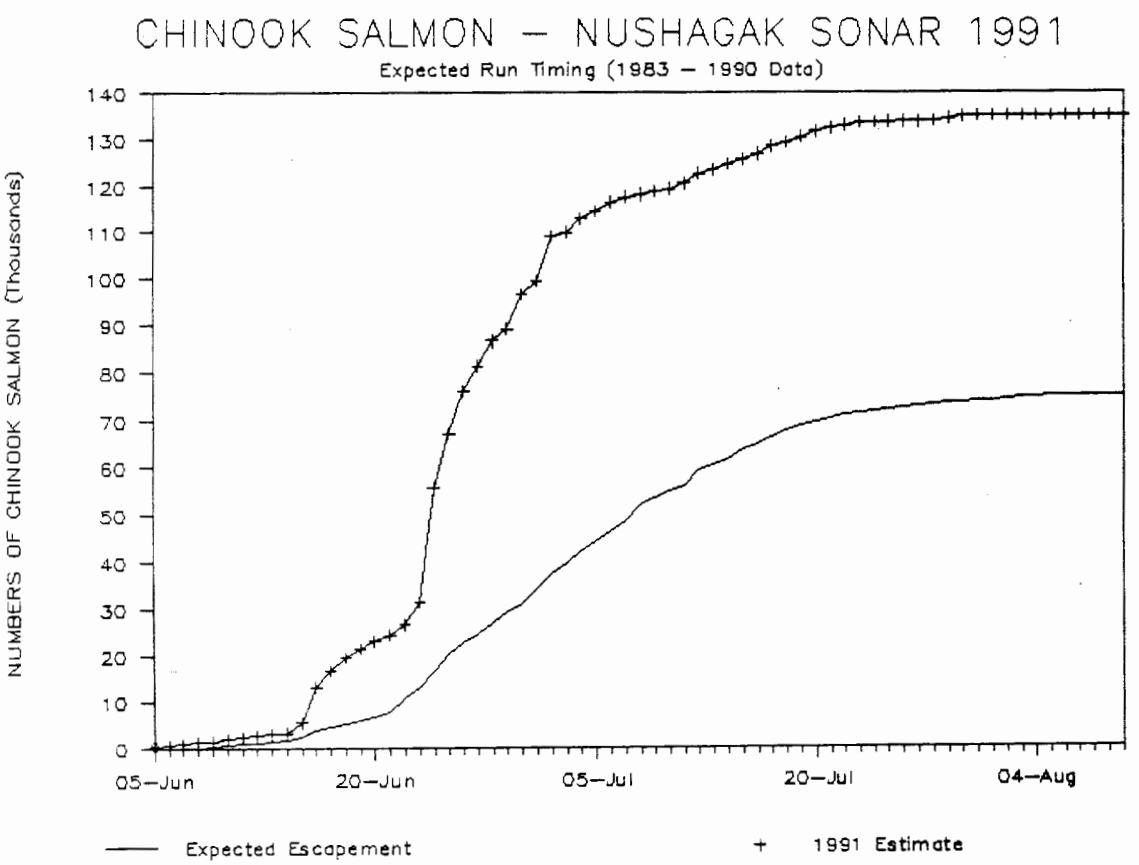
Appendix D.1 (p 3 of 3)

Date	1980	1981	1982	1983	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a] Daily	Average Proportion[a] Cumulative
8 16			0	0	0	0	0	0	0	0	0		
8 17			0	0	0	0	0	0	0	0	0		
8 18			0		0			0	0	0	0		
8 19					0			0	0	0	0		
8 20					0			0	0	0	0		
8 21					0			0	0	0	0		
Totals	62,780	130,252	126,438	103,767	98,991	43,434	84,309	56,905	78,302	63,955	135,054		

[a] Average proportions for 1983, 1985 - 1991, June 5 through August 10.





Appendix D.2 Daily chinook salmon escapement estimates and average run timing, Nushagak River sonar, 1983 - 1991.

Appendix E.1 Daily sockeye salmon escapement estimates and average run proportions, Nushagak River sonar, 1980 - 1991.

													Average Proportion[a]	
Date	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Daily	Cumulative
6 04					149									
6 05					457							0		
6 06					574		0	0		2	11	0		
6 07					591		3	0	2	4	11	0		
6 08					622		2	0	3	3	32	0		
6 09					624		3	0	11	14	145	0		
6 10					450	0	15	0	25	19	33	0		
6 11				253	385	19	6	0	18	9	23	0	0.02	0.02
6 12		243		335	254	5	15	0	5	23	15	0	0.02	0.04
6 13		457		454	362	42	71	0	6	25	52	0	0.03	0.08
6 14		420	120	282	787	48	76	0	4	23	37	0	0.03	0.11
6 15		323	252	437	1,440	7	32	0	106	25	149	411	0.06	0.17
6 16		573	23	297	1,528	6	37	0	185	24	117	855	0.07	0.23
6 17		1,514	64	282	3,478	4	16	332	71	78	51	247	0.10	0.34
6 18		972	78	306	1,380	8	14	540	50	114	43	219	0.07	0.41
6 19		893	481	292	2,519	82	112	301	41	21	47	137	0.08	0.49
6 20		1,247	338	790	1,544	3,124	141	217	65	64	0	314	0.17	0.66
6 21		5,134	0	606	1,019	2,616	88	115	27	361	0	867	0.19	0.85
6 22	352	3,426	7,133	3,385	3,030	915	119	145	28	1,082	995	1,565	0.44	1.28
6 23	476	2,490	23,182	1,653	3,475	1,698	229	154	50	1,372	5,297	3,407	0.71	1.99
6 24	528	239	39,230	5,455	11,295	369	270	740	54	3,460	1,960	8,830	1.29	3.28
6 25	737	0	7,133	2,890	83,644	229	1,091	3,275	8,697	15,260	1,009	11,476	2.12	5.40
6 26	1,339	0	0	3,749	54,222	419	3,392	4,456	19,752	36,432	320	10,667	2.21	7.61
6 27	1,670	195	8,916	4,125	48,318	421	4,282	2,145	15,167	24,731	355	5,084	1.88	9.49
6 28	268	1,701	21,398	9,926	14,201	305	1,583	4,039	16,237	14,893	1,540	13,962	1.91	11.39
6 29	111	3,287	14,266	4,826	18,904	908	853	16,046	5,819	3,495	1,935	54,173	2.22	13.61
6 30	3,688	6,143	16,049	7,235	44,465	1,400	946	47,423	2,392	37,613	1,604	16,097	3.31	16.92
7 01	25,625	76,193	41,014	9,534	31,261	53,282	5,874	66,559	1,466	34,028	9,858	60,848	7.09	24.01
7 02	104,306	41,641	37,447	9,224	58,296	35,792	9,468	84,275	1,708	57,488	85,624	17,820	8.17	32.19
7 03	240,530	52,501	35,664	4,781	22,133	18,234	5,414	39,477	4,345	55,416	55,341	91,915	7.97	40.15
7 04	294,491	82,221	32,098	8,079	8,840	13,382	18,067	19,411	45,767	106,391	23,207	97,608	9.40	49.56
7 05	222,282	223,247	30,314	28,917	37,884	13,210	34,648	9,143	42,967	15,922	8,977	34,640	8.87	58.43
7 06	97,901	150,089	37,447	10,492	55,571	16,440	44,969	5,523	10,097	14,731	34,852	3,670	6.03	64.46
7 07	54,034	25,267	23,182	7,959	15,876	12,124	57,760	5,930	11,032	19,106	314,041	2,024	7.04	71.50
7 08	23,484	22,271	24,965	8,792	14,680	21,881	46,419	18,647	11,348	12,635	56,812	1,492	3.98	75.48

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Appendix E.1 (p 2 of 3)

Date	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a] Daily	Cumulative
7 09	9,973	22,068	5,350	6,926	14,618	19,258	41,217	22,710	52,969	5,812	10,124	1,189	3.48	78.96
7 10	9,223	42,360	7,133	5,818	15,366	10,439	104,907	2,918	57,393	9,242	4,864	1,676	3.76	82.71
7 11	4,603	22,629	14,266	3,063	5,264	6,703	144,139	1,025	57,062	3,442	2,752	3,068	3.53	86.24
7 12	4,355	12,296	8,916	3,059	3,175	8,538	125,352	1,370	85,645	12,543	7,528	4,318	3.89	90.13
7 13	451	6,774	12,482	2,338	1,465	5,459	68,323	1,095	11,291	4,313	6,579	2,324	1.67	91.82
7 14	553	3,517	5,350	3,055	909	11,785	20,310	899	2,097	4,903	3,799	3,346	1.07	92.89
7 15	312	1,213	5,350	3,180	691	22,640	72,800	2,286	857	2,713	3,165	2,302	1.12	94.01
7 16	289	343	7,133	3,018	803	12,476	17,099	2,044	888	1,946	2,129	3,926	0.97	94.99
7 17	9,681		10,699	1,546	1,912	8,491	8,942	1,932	1,891	2,692	1,953	6,548	0.90	95.89
7 18	7,883		7,133	1,739	532	7,469	3,798	2,316	1,877	4,090	1,319	9,526	0.82	96.70
7 19	920		16,049	1,688	393	2,708	4,005	2,121	816	1,477	845	8,750	0.69	97.40
7 20	1,031		5,350	1,823	671	928	2,255	2,920	1,532	1,223	883	3,205	0.41	97.80
7 21	1,084		7,133	271	966	1,616	1,820	5,435	2,286	1,294	1,206	1,840	0.43	98.23
7 22			5,350	280	733	1,484	878	2,197	2,219	376	2,785	1,886	0.31	98.54
7 23			7,133	326	124	1,226	2,273	1,082	442	387	3,579	1,402	0.29	98.83
7 24			7,133	343	368	395	3,589	1,312	639	413	3,278	298	0.27	99.10
7 25			1,783	424	338	1,402	2,015	886	911	277	483	176	0.15	99.25
7 26			1,783	398	286	898	1,370	896	275	148	572	179	0.14	99.39
7 27			0	395	0	658	2,557	832	254	75	600	36	0.07	99.46
7 28			0	422	0	258	329	530	208	90	788	101	0.06	99.52
7 29			0	429	0	42	847	400	163	84	1,204	367	0.06	99.58
7 30			0	275	0	36	182	462	343	177	1,220	152	0.05	99.63
7 31			0	0	0	47	60	289	645	502	763	64	0.04	99.67
8 01				0	0	37	205	276	410	128	130	65	0.02	99.69
8 02				0	0	36	248	311	0	38	138	0	0.01	99.70
8 03				0	0	42	0	248	0	45	735	0	0.02	99.72
8 04				0	0	142	663	23	0	29	188	0	0.01	99.74
8 05				0	0	0	322	61	285	25	1,175	0	0.02	99.76
8 06				0	0	0	178	103	294	35	2,993	0	0.05	99.80
8 07				0	0	0	69	50	355	38	1,788	0	0.03	99.83
8 08				0	0	0	58	20	476	0	5,030	0	0.07	99.90
8 09				0	0	18	52	8	279	0	867	5	0.02	99.92
8 10				341	0	11	98	13	140	0	0	7	0.02	99.94
8 11				152	0	6	193	8	132	0	0	10	0.01	99.96
8 12				125	0	26	224	11	211	0	0	9	0.01	99.97

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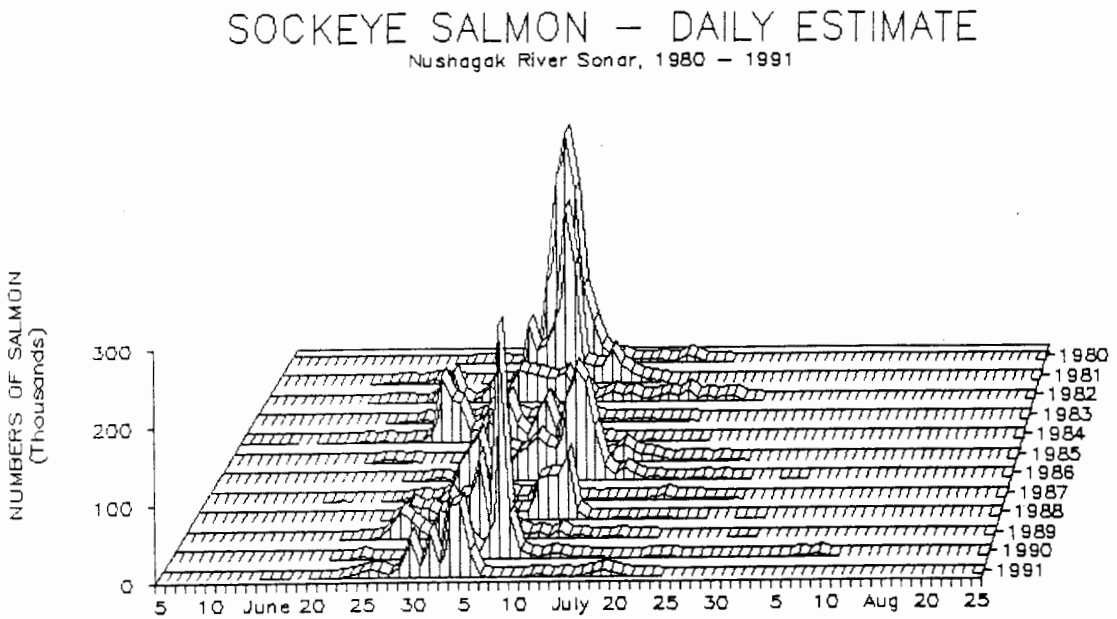
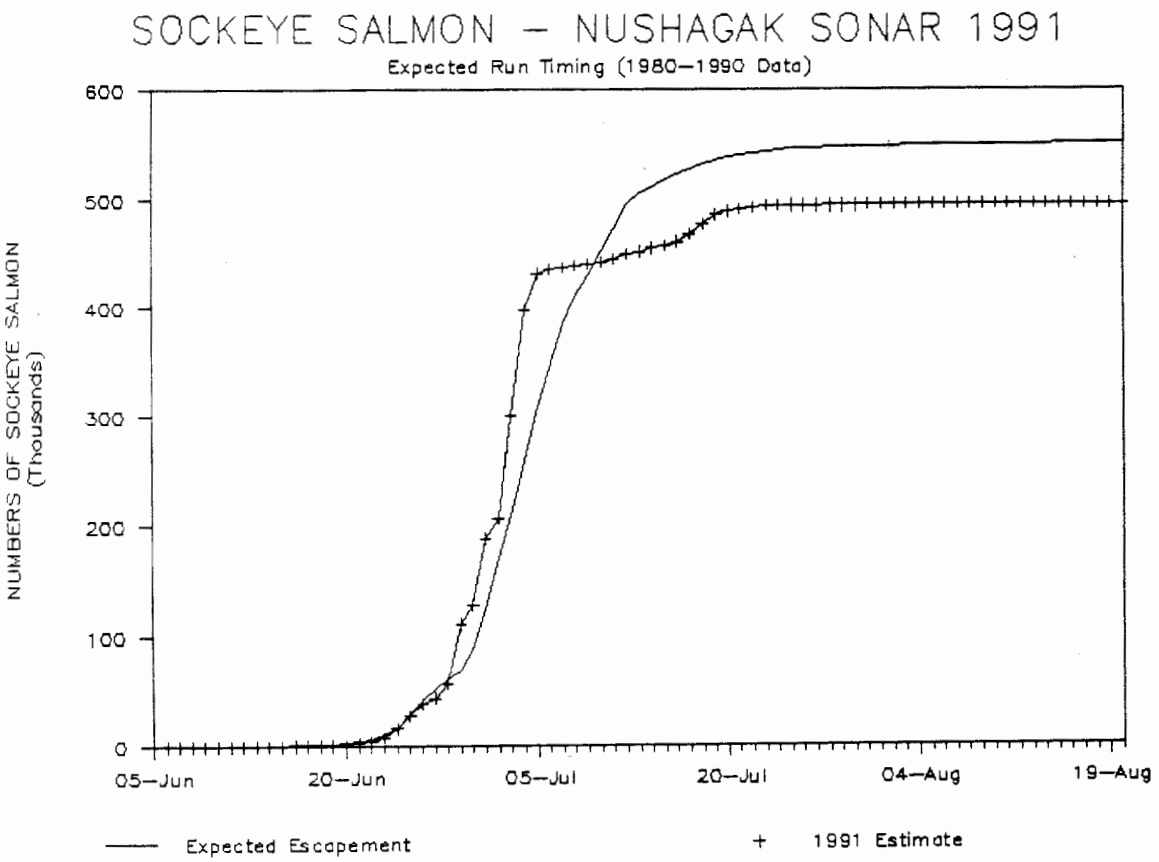
Appendix E.1 (p 3 of 3)

Date	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a] Daily	Average Proportion[a] Cumulative
8 13				94	0	21	123	14	71	0	236	3	0.01	99.98
8 14				73	0	37	195	7	79	0	177	0	0.01	99.99
8 15				76	0	10	67	12	43	0	0	0	0.01	99.99
8 16				66	0	5	31	9	36	0	0	0	0.00	99.99
8 17				42	0	2	38	10	62	0	0	0	0.00	100.00
8 18					0	2			31	0	0	0		
8 19					0	2			13	0	0	0		
8 20					0	3			9	0	0	0		
8 21					0	1			15	0	0	0		
Total	1,136,445	813,887	537,686	177,141	592,872	322,327	867,846	388,033	483,200	513,421	680,368	495,106		

[a] Average proportions for 1980 - 1991, June 11 through August 17.





Appendix E.2 Daily sockeye salmon escapement estimates and average run timing, Nushagak River sonar, 1980 - 1991.

Appendix F.1 Daily chum salmon escapement estimates and average run proportions, Nushagak River sonar, 1980 - 1991.

													Average Proportion[a]	
Date	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Daily	Cumulative
6 04					100									
6 05					305							0		
6 06					383		1	9		2	35	0		
6 07					394		8	19	65	128	36	0		
6 08					415		5	22	94	149	88	0		
6 09					416		6	152	205	103	322	0		
6 10					300	0	37	150	545	112	94	0		
6 11				0	257	3	8	63	501	11	66	0	0.04	0.04
6 12		364		0	289	0	25	127	112	31	51	0	0.05	0.10
6 13		686		0	328	9	139	68	123	44	149	0	0.08	0.18
6 14		630	100	0	524	17	166	53	85	106	104	0	0.08	0.25
6 15		485	210	0	960	6	79	57	2,650	71	2,191	696	0.28	0.54
6 16		859	199	0	1,018	4	80	37	5,774	127	1,691	2,118	0.49	1.03
6 17		330	512	0	331	2	40	786	1,839	127	747	716	0.23	1.26
6 18		212	565	0	1,380	1	25	1,313	1,241	180	618	598	0.25	1.52
6 19		162	401	0	504	66	245	751	924	48	665	387	0.18	1.69
6 20		95	282	0	309	6,283	220	553	1,579	103	1,627	545	0.47	2.16
6 21		391	3,895	487	29	3,209	126	274	764	1,377	4,766	965	0.61	2.77
6 22	704	3,084	3,895	2,718	19	1,414	235	357	666	4,053	61,168	1,743	2.32	5.09
6 23	953	2,845	1,948	1,327	2,824	2,846	509	394	1,181	5,035	13,549	3,751	1.19	6.28
6 24	2,072	239	7,790	4,380	7,530	703	757	8,520	1,549	12,896	5,180	33,521	2.95	9.23
6 25	2,890	1,275	5,194	2,321	13,207	310	6,649	24,484	37,375	13,309	2,668	12,433	4.89	14.12
6 26	5,252	2,106	14,282	2,939	26,651	531	7,461	9,730	24,871	37,152	787	11,476	4.79	18.91
6 27	6,550	715	12,335	3,235	23,750	1,354	9,871	4,533	6,206	19,834	942	12,388	3.33	22.25
6 28	5,001	454	10,387	7,783	67,031	1,306	12,630	8,737	6,181	11,501	152	8,224	4.57	26.82
6 29	2,081	876	1,948	3,784	89,225	347	6,843	2,225	1,784	12,653	190	3,466	3419	30.23
6 30	1,229	1,117	7,790	5,673	17,242	541	7,480	16,250	750	14,558	137	8,773	3.12	33.35
7 01	3,750	2,432	9,738	1,733	10,212	18,749	2,843	26,278	551	17,800	37,878	6,592	4.81	38.16
7 02	8,204	9,497	7,141	1,677	8,093	27,024	4,135	12,608	556	23,527	27,403	8,728	4.76	42.92
7 03	27,026	6,655	21,424	869	17,438	9,186	2,117	5,688	1,607	25,766	23,937	17,840	4.84	47.76
7 04	60,317	2,868	6,492	1,469	6,965	6,889	2,568	2,335	8,898	35,698	6,148	59,888	5.92	53.68
7 05	59,845	4,556	5,194	8,238	11,430	6,848	7,630	1,246	7,069	11,076	2,364	18,440	4.72	58.40
7 06	36,136	4,642	2,597	2,989	4,015	8,293	3,154	472	2,746	9,763	19,729	1,403	2.93	61.33
7 07	12,312	32,159	3,246	2,267	9,355	6,201	1,128	440	2,981	12,403	19,224	835	3.86	65.19
7 08	6,021	10,964	9,089	2,505	7,234	7,338	4,644	1,311	3,053	7,878	28,154	635	3.05	68.24

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Appendix F.1 (p 2 of 3)

Date	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a] Daily	Cumulative
7 09	3,989	4,872	3,895	1,973	3,765	6,601	5,551	2,532	1,135	7,435	6,448	499	1.80	70.04
7 10	2,755	11,948	7,141	1,657	2,561	5,348	11,008	574	6,152	11,640	10,333	734	2.76	72.80
7 11	4,817	6,383	8,440	3,205	2,507	4,401	8,089	301	6,382	6,060	3,337	1,296	2.20	75.00
7 12	6,189	6,149	8,440	3,201	0	1,178	27,386	333	24,133	16,412	2,854	1,632	3.98	78.98
7 13	4,895	7,877	9,089	2,447	932	746	7,314	295	5,310	5,646	2,472	975	1.95	80.94
7 14	4,431	6,180	2,597	3,198	578	1,596	2,138	258	840	5,343	1,035	1,429	1.22	82.15
7 15	2,496	7,187	2,597	3,327	440	18,524	4,709	540	368	6,137	564	1,084	1.99	84.14
7 16	3,572	2,030	2,597	2,910	511	10,549	5,500	552	379	4,551	436	1,844	1.42	85.56
7 17	14,521		3,895	1,491	1,217	4,898	2,933	509	756	5,902	612	3,478	1.40	86.96
7 18	31,534		7,141	1,677	5,322	4,215	1,223	606	667	9,144	496	3,018	2.04	89.00
7 19	3,680		5,843	1,628	4,716	20,261	1,284	650	296	3,366	651	3,901	1.78	90.78
7 20	4,122		8,440	1,758	1,343	5,744	1,481	1,037	531	4,094	702	2,922	1.24	92.02
7 21	4,334		2,597	1,174	3,381	5,687	1,136	1,876	742	4,173	1,011	1,756	1.03	93.06
7 22	0		1,948	1,214	2,565	5,002	695	954	728	1,375	2,313	3,732	0.89	93.94
7 23	0		1,298	1,413	62	4,338	752	561	913	1,371	2,872	2,394	0.73	94.67
7 24	0		2,597	1,488	184	1,403	1,178	690	1,258	1,322	2,703	576	0.63	95.31
7 25	0		2,597	1,839	169	358	661	513	1,985	891	2,641	344	0.59	95.90
7 26	0		2,597	1,989	143	219	161	564	797	510	2,495	322	0.50	96.40
7 27	0		2,597	1,974	117	160	354	480	723	317	2,265	122	0.47	96.87
7 28	0		1,948	2,109	74	71	120	341	691	375	4,130	406	0.50	97.37
7 29	0		649	2,146	159	20	0	259	525	249	601	1,588	0.36	97.73
7 30	0		649	1,377	239	11	922	303	1,054	483	525	756	0.35	98.08
7 31	0		649	957	663	18	305	180	1,602	1,279	318	269	0.30	98.38
8 01	0		0	660	0	18	0	190	1,102	375	447	263	0.17	98.55
8 02	0		3,246	790	0	12	0	174	489	126	46	327	0.27	98.81
8 03	0		0	734	0	16	0	142	436	0	269	137	0.11	98.93
8 04	0		0	658	258	43	641	161	156	0	557	118	0.15	99.07
8 05	0		0	73	0	122	310	478	205	0	828	76	0.10	99.18
8 06	0		0	118	0	174	155	686	170	0	3,290	158	0.19	99.36
8 07			0	110	0	110	80	260	248	0	1,863	87	0.11	99.47
8 08			0	281	0	472	65	101	945	62	5,102	41	0.26	99.73
8 09			0	309	0	445	62	45	175	568	896	0	0.11	99.84
8 10			0	0	0	172	141	47	0	549	0	0	0.03	99.87
8 11			0	0	0	206	58	31	0	136	0	0	0.02	99.89
8 12			0	0	0	487	0	19	0	0	0	0	0.02	99.91

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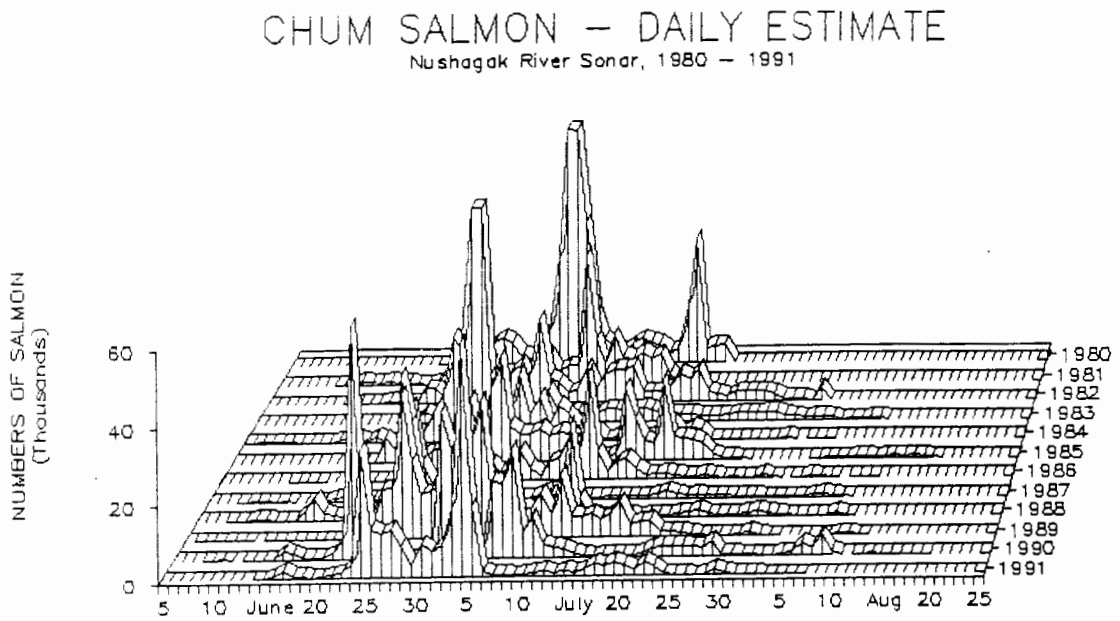
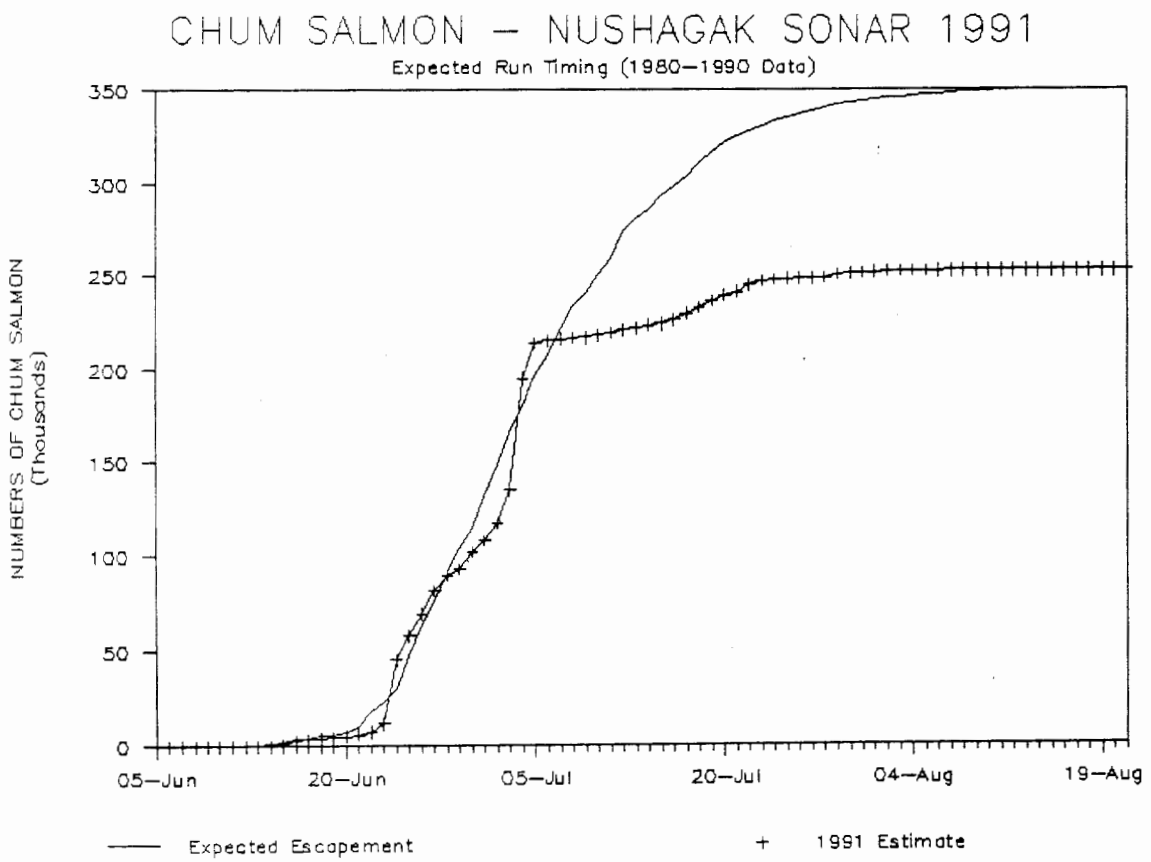
Appendix F.1 (p 3 of 3)

Date	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a]	
													Daily	Cumulative
8 13			0	0	0	260	0	21	0	0	297	0	0.02	99.94
8 14			0	0	0	511	0	23	0	0	199	0	0.03	99.97
8 15			0	0	0	231	0	38	0	0	47	0	0.01	99.98
8 16			0	0	0	145	0	37	0	0	16	0	0.01	99.99
8 17			0	0	0	71	0	30	0	0	97	0	0.01	100.00
8 18			0		0	54			0	0	97	0		
8 19					0	54			0	0	68	0		
8 20					0	41			0	0	0	0		
8 21					0	9			0	0	0	0		
Total	331,678	143,324	230,141	106,279	362,369	214,481	168,276	147,430	186,418	377,512	329,793	252,436		

[a] Average proportions for 1980 - 1991, June 11 through August 17.





Appendix F.2 Daily chum salmon escapement estimates and average run timing, Nushagak River sonar, 1980 - 1991.

Appendix G.1 Daily coho salmon escapement estimates and average run proportions, Nushagak River sonar, 1982 - 1991.

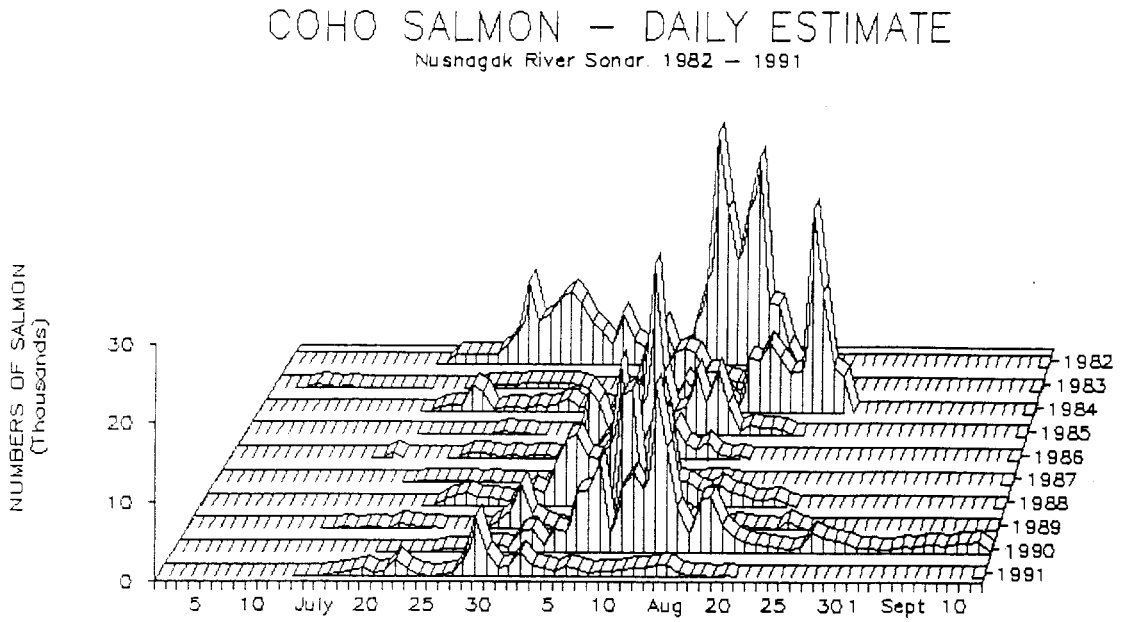
											Average Proportion[a]	
Date	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Daily	Cumulative
7 02	0	0	0	0	0	0	0	0	0	0	0.00	0.00
7 03	0	0	0	0	0	0	0	0	0	0	0.00	0.00
7 04	0	0	0	0	0	0	0	0	0	0	0.00	0.00
7 05	0	336	0	0	0	0	0	0	0	0	0.11	0.11
7 06	0	122	0	0	0	0	0	0	0	0	0.04	0.15
7 07	0	93	0	0	0	0	0	0	0	0	0.03	0.18
7 08	0	102	0	0	0	0	0	0	0	0	0.03	0.21
7 09	0	81	0	0	0	0	0	0	0	0	0.03	0.24
7 10	0	68	0	0	0	0	0	0	0	0	0.02	0.26
7 11	0	71	0	0	0	0	0	0	0	0	0.02	0.28
7 12	0	71	0	0	0	0	0	0	0	0	0.02	0.31
7 13	0	54	0	0	0	0	0	0	0	0	0.02	0.33
7 14	0	71	0	0	0	0	0	0	0	0	0.02	0.35
7 15	0	74	0	0	0	0	0	246	0	127	0.09	0.44
7 16	0	0	0	0	708	0	0	172	0	221	0.26	0.70
7 17	1,354	0	0	0	0	0	0	250	0	570	0.24	0.95
7 18	1,354	0	532	0	0	0	0	374	0	706	0.34	1.28
7 19	1,354	0	786	127	0	0	0	133	25	1,133	0.46	1.74
7 20	1,354	0	671	73	0	177	0	670	30	515	0.44	2.18
7 21	1,354	406	3,381	131	0	320	0	551	51	736	0.91	3.09
7 22	2,708	420	2,565	106	0	163	0	322	114	2,261	1.21	4.30
7 23	4,062	489	186	101	575	96	810	287	127	978	0.93	5.24
7 24	10,833	515	552	33	748	118	1,166	0	131	256	1.10	6.34
7 25	5,416	637	508	575	416	88	1,674	0	432	99	0.90	7.24
7 26	6,771	597	429	367	234	97	1,059	0	494	159	0.84	8.08
7 27	8,387	592	820	269	386	82	976	0	508	568	1.06	9.13
7 28	9,479	633	515	106	184	58	808	0	701	1,959	1.38	10.51
7 29	8,125	644	1,115	19	480	44	632	1,263	960	7,552	3.09	13.60
7 30	5,416	413	1,672	15	453	52	1,326	2,362	991	3,117	1.96	15.56
7 31	4,062	0	663	20	226	31	2,464	6,066	621	1,211	1.66	17.22
8 01	2,708	0	632	17	914	33	1,574	1,886	2,574	1,242	1.30	18.53
8 02	6,771	0	728	15	1,426	30	5,174	669	3,238	3,016	2.28	20.80
8 03	3,300	0	478	18	8,951	24	8,513	269	1,033	1,385	3.69	24.49
8 04	2,200	0	1,032	59	7,144	1,529	9,168	175	3,068	1,115	4.16	28.65
8 05	1,354	1,212	799	4,124	3,461	4,594	6,362	150	2,701	745	5.40	34.05
8 06	5,416	1,948	7,126	5,979	1,804	6,479	6,033	208	7,695	1,424	7.65	41.70

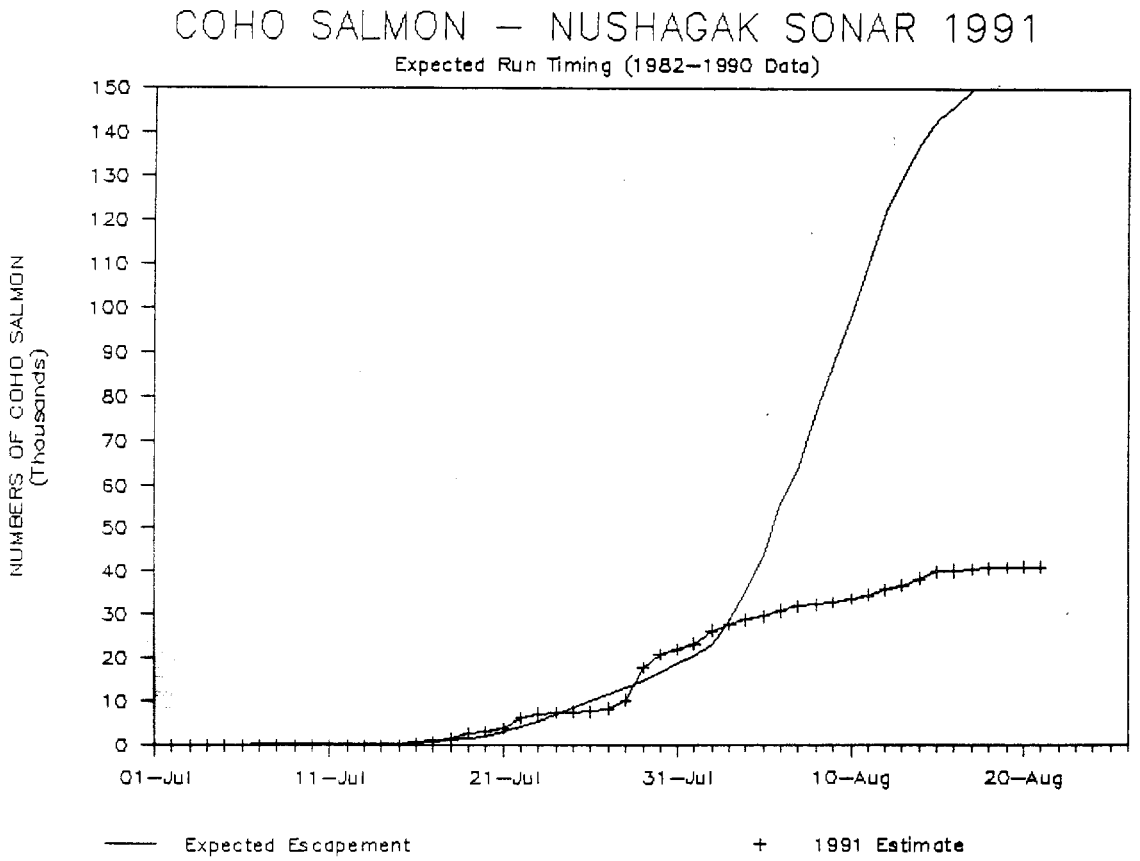
-Continued-

Appendix G.1 (p 2 of 2)

Date	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average Proportion[a] Daily	Average Proportion[a] Cumulative
8 07	1,354	1,819	5,191	3,900	831	2,379	7,837	227	8,062	812	4.54	46.23
8 08	1,354	4,638	695	22,181	681	917	18,480	1,625	11,915	445	7.95	54.18
8 09	5,416	5,105	955	7,880	636	414	5,903	17,005	2,513	591	6.45	60.62
8 10	10,833	4,435	4,321	2,908	1,362	489	7,888	17,916	8,305	764	7.00	67.63
8 11	51,456	1,981	2,335	3,731	4,376	320	11,607	3,778	10,354	871	7.18	74.81
8 12	20,312	1,629	5,235	8,459	2,009	179	11,984	13,365	8,011	1,224	7.15	81.96
8 13	13,541	1,215	5,050	4,289	1,179	193	3,359	5,738	21,355	1,083	5.10	87.06
8 14	20,000	944	1,881	8,554	2,106	238	3,278	2,300	13,331	1,526	4.99	92.04
8 15	27,082	982	426	4,098	728	387	2,107	1,568	5,943	1,618	3.65	95.69
8 16	8,180	855	6,995	605	362	387	1,928	704	2,382	377	2.06	97.75
8 17	7,873	552	6 616	1,286	391	302	2,852	339	6,794	164	2.25	100.00
8 18	2,653		8,938	960			1,701	350	7,238	268		
8 19			6,872	963			1,421	795	3,450	128		
8 20			4,880	698			799	470	2,063	144		
8 21			5,463	156			911	352	1,301	43		
8 22			26,267				1,016	291	1,078			
8 23			15,314				291	195	864			
8 24			5,782					1,275	694			
8 25			4,435					282	557			
8 26								78	808			
8 27									2,801			
8 28									2,130			
8 29									1,662			
8 30									1,458			
8 31									848			
9 01									722			
9 02									484			
9 03									602			
9 04									1,011			
9 05									831			
9 06									1,064			
9 07									1,283			
9 08									984			
9 09									1,289			
9 10									1,373			
9 11									1,512			
9 12									287			
Totals	263,832	33,804	142,841	82,822	42,771	20,219	131,101	84,707	162,853	41,980		

[a] Average proportions for 1982 - 1991, July 2 through August 17.





Appendix G.2 Daily coho salmon escapement estimates and average run timing, Nushagak River sonar, 1982 - 1991.