AN ESTIMATE OF THE 1988 TOTAL SOCKEYE SALMON RETURN TO UPPER COOK INLET, ALASKA USING A TEST FISHERY

By: Kenneth E. Tarbox
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Regional Information Report[1] No. 2S89-4

Alaska Department Of Fish And Game
Division Of Commercial Fisheries
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ABSTRACT

During the 1988 Upper Cook Inlet, Alaska commercial salmon fishing season a test fishery was used to estimate the total return of sockeye salmon (*Oncorhynchus nerka*) to the Inlet. The fishery operated from 1-30 July and captured 1,440 sockeye salmon (1131.2 CPUE points). Seven estimates of total return were made during the season utilizing run timing curves from previous years. Post season analysis indicated 9.0 million fish returned to the Inlet in 1988. The in-season estimates ranged from 9.3 million to 17.3 million fish. Maximum error of estimation was recorded near the 50% point of the return. Passage rate (inverse of catchability) ranged from 5,168 to 8,952 sockeye salmon/CPUE point. Mean date of the return was 13 July and the test fishery encompassed approximately 84% of the run.

Potential sources of error related to starting date of the project, calculation of passage rate, estimates of fish in the fishing districts following a fishing period, and curve fitting procedures.

KEY WORDS: Salmon, *Oncorhynchus*, Upper Cook Inlet, Alaska, test fishery, migratory behavior

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INTRODUCTION

In 1979, the Alaska Department of Fish and Game (ADF&G) began a test fishing project near the southern boundary of the Upper Cook Inlet (UCI) salmon management area (Figure 1). The objective of this project was to estimate the total return of sockeye salmon (*Oncorhynchus nerka*) to UCI during the fishing season. Concurrent with other programs, ADF&G salmon biologists could then alter fishing times and areas to achieve desired exploitation rates.

Test fishing results have been reported annually since 1979 (Waltemyer 1983a, 1983b, 1986a, 1986b, Hillsinger and Waltemyer 1986, Hillsinger 1988). This report presents the results of the 1988 test fishing project.

METHODS

Test Fish Sampling

Sockeye salmon returning to Upper Cook Inlet were sampled by fishing 11 evenly spaced stations between Anchor Point and Red River Delta (Figure 1). Stations were numbered consecutively from east to west.

The test fishing vessel started at Anchor Point and sampled at stations 2, 4, 5, 6, 7 and 8 in one day. The following day, the vessel sampled at stations 9, 7, 6, 5 and 3. This same routine was followed throughout the sampling period. Station locations were determined from LORAN C coordinates.

Sampling started on 1 July in 1988, rather than the normal starting date of 24 June used in previous years, and continued through 30 July. The 14.6 m (48 ft) seiner type vessel *F/V Corrina Kay* was equipped with 200 fm (4 shackles at 50 fm each) of 2.1 cm (5 1/8 in) multifilament gill net. Drift gill net web specifications were filament size number 53/S6F, 45 meshes deep, double knot construction, and Super Crystal shade number 1.

Salmon captured were identified by species and sex. All sockeye salmon were measured for length (mid-eye to fork of tail in mm). The number of fish caught by station and species was transformed into a catch per unit of effort (CPUE) statistic by the following formula:

$$\text{CPUE} = \frac{100 \text{ fm} \times 60 \text{ min} \times \text{number of fish}}{\text{fm of gear} \times \text{mean fishing time}}$$

Mean fishing time (MFT) was calculated using the following formula:

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$$MFT = (C - B) + \frac{[B - A] + [D - C]}{2}$$

where: A = time when set was started
B = time when net was fully set out
C = time when retrieval was started
D = time when net was fully retrieved

Fishing time for a compliment of gear was normally 30 min before retrieval was started.

Daily CPUE was determined by summing the CPUE for individual stations. If stations were not fished, the CPUE for those stations was imputed using a linear interpolation between the previous and following day's CPUE. The daily CPUE for the period 24 June (normal starting date) through 30 June was estimated post season using the CPUE proportions of 1985 (year of best fit). These proportions were not used in the in-season estimation of the total sockeye salmon return.

Physical and chemical measurements were taken concurrent with each set and included air and water temperature (at 1 m below the surface), wind velocity and direction, tide stage, water depth and clarity, and salinity. Air and water temperatures and salinity were measured using a YSI salinity/temperature meter. Wind speed was measured in knots and direction was recorded as (0) no wind, (1) north, (2) north-east, (3) east, (4) southeast, (5) south, (6) southwest, (7) west, or (8) northwest. Tide stage was determined by observing the movement of the vessel during the test fish drift. Water depth was measured in fathoms (fm) using a Simrad echo sounder, and water clarity was measured in meters (m) using a 17.5 cm secchi disk.

Describing the Salmon Migration

An estimate of the sockeye salmon return was made at intervals during the fishing season by estimating the expected total test fishery CPUE for the season and catchability of sockeye salmon in the test fishery. The steps of the procedure are outlined below.

Estimates of the expected total CPUE were made during the fishing season using the following equation:

$$C_t = \Sigma(c_t^2)/\Sigma((y_t)(c_t))$$

where: C_t = estimated total CPUE on day t
c_t = cumulative CPUE at the test fishery on day t
y_t = the cumulative proportion of total CPUE on day t observed in previous individual years (1979-87) and for historical averages (1979-87,1982-86,1982-87)

Mundy (1979) provided a detailed development of this equation.

The computations provided 12 independent estimates of expected total CPUE for each time interval. Therefore, the estimate of total CPUE that provided the minimum sum of squared deviation (MSSDEV) between a prior year or year group average and the current year's proportions was considered the best estimate.

Catchability, the fraction of the migration taken by a single unit of fishing effort, was estimated as follows:

$$q_t = c_t/r_t$$

where: q_t = estimated catchability on day t
r_t = adjusted cumulative total return on day t

The cumulative sockeye salmon total return on day t was calculated by adding daily reported harvest estimates and observed sockeye salmon escapement. This figure was then adjusted to account for the following:

1) Escapement into systems which were not monitored. Only the Kasilof, Kenai, Crescent, and Yentna Rivers and Fish Creek were monitored during 1988. Other systems have historically provided from 6.4% to 31.4% of the escapement. Daily observed escapement was adjusted upward by 15% to account for other systems.

2) Residual abundance of fish in Upper Cook Inlet. Catch was expanded to reflect the number of unharvested fish in the inlet following a fishing period using the daily exploitation rates of 0.4 for the drift gill net fishery and 0.6 for the set net fishery.

The expected total return of sockeye salmon to UCI was calculated by the equation:

$$N_t = C_t/q_t = C_t \times PR$$

where: N_t = estimated total return for the season on day t
$PR = 1/q_t$ = passage rate

Post season, because the test fishery did not encompass the entire sockeye salmon run, the total CPUE for the test fishery was estimated post season using the following formula:

$$CPUE_s = CPUE_{tf} \times \frac{Catch_s}{Catch_{tf}}$$

where: $CPUE_s$ = total estimated CPUE for the season
$CPUE_{tf}$ = cumulative CPUE through 30 July
$CATCH_s$ = total commercial catch for the season
$CATCH_{tf}$ = commercial catch through 30 July

The post season estimate of total CPUE and the daily CPUE values were used to compute daily and cumulative proportions of the total CPUE, based on the non-linear model:

$$y = 1/(1 + e^{-(a+bt)}),$$

Catchability, passage rate, and calculations of relative error of the in-season estimates of total CPUE were also made post season using the post season estimate of total CPUE.

RESULTS

A total of 1,440 sockeye salmon, 82 pink salmon, 683 chum salmon, 322 coho salmon, and 5 chinook salmon were captured during the test fishery in 1988 (Table 1, Appendix A-D). Daily sockeye salmon catches ranged from 9 fish on 7 July to 156 fish on 3 July (Table 1). CPUE values ranged from 7.3 to 93.6 for the same dates with a total CPUE measured from actual fishing of 1,131.2 (Table 1).

The distribution of the test fish sockeye salmon harvest along the transect was similar to CPUE. Approximately 84% of the sockeye salmon captured were taken at stations 5, 6, and 7 (Table 2), while 81.8% of the total CPUE was also accounted for at these stations (Table 3).
Daily and cumulative CPUE estimates, including those calculated post season for the period 24 June to 1 July, are presented in Table 4 and Figures 2 and 3. Approximately 67 CPUE points were imputed to the measured cumulative total because the project started later than the historical data base. Using the post season harvest figures, it was estimated that the total CPUE for the test fishery would have been 1,226 CPUE points. Therefore, the measured CPUE values were approximately 92.3% of the estimated total.

Sockeye salmon escapement, harvest and total return data recorded in-season are presented in Tables 5 and 6. These data were used in the calculation of the total in-season return estimates and therefore are presented for re-creation of in-season results only. Final harvest and escapement numbers by fishery and river system are being compiled by ADF&G staff.

The total sockeye salmon return migrating to UCI in 1988 was estimated at 9.0 million fish. However, because of fishing effort in the Kodiak Island area, approximately 500,000 fish were commercially harvested prior to reaching UCI. Thus the actual number of fish passing the test fishery transect was 8.5 million.

Seven estimates of total return were made during the 1988 fishing season. Estimates ranged from 17.3 million sockeye salmon on 15 July to 9.3 million fish on 29 July (Table 7). The in-season estimates consistently overestimated the return calculated post season. The high estimate was 92.2% greater than the actual return (Table 8). Total CPUE estimates ranged from 2,408 on 8 July to 1,252 on 29 July. The error associated with these estimates was 96.4% and 2.1% (Table 8).

The estimate of passage rate for the season was 6,933 sockeye salmon with in-season estimates ranging from 5,168 to 8,952 fish (Table 9).

Daily and cumulative proportions (estimated post season) of the sockeye salmon return to UCI are presented in Appendix E. These estimates suggested that 9.79% of the return was past the transect when the test fishery began on 1 July, and that the return was 93.6% completed at the termination of the project (Figure 4). The mean date of the return occurred on 13 July 1988 which is one day earlier than the historic average (Table 10).

Physical and chemical measurements made at the time of each set are presented in Appendix F. Temperatures of water masses sampled indicated relatively warm waters (10°C) early in July followed by decreasing trend for the remainder of the month (8°C; Figure 5). Air temperatures fluctuated substantially during the month with high temperatures approaching 21°C (Figure 5; Appendix F). Salinity measurements ranged from 28 ppt on 1 July to 36 ppt at station 8 on 5 July (Appendix F, Figure 6 presents daily average salinities from all stations combined). Wind velocities during the project were extremely variable with over 11 days of 20 knot winds recorded at one or more stations (Appendix F). Wind direction was typically from the south or southwest.

DISCUSSION

The main goal of this project was to provide accurate and early estimates of the total return of sockeye salmon to UCI. In this context the 1988 test fishery proved unacceptable. At a critical point of the fishery (15 July) the return estimate was nearly twice the actual return. However, from 17 July to completion of the project estimates were within 25% of the actual return.

Examination of potential sources of error in the program revealed a number of areas needing further investigation. These include accuracy of in-season catch, escapement, and residual fish in the district estimates; calculation of passage rate; the procedure of curve fitting present year data to previous years; and the period of data collection. These sources of error are discussed below.

Accuracy of In-season Harvest Data

Comparison of in-season and post season harvest figures (Table 11) indicated that overall in-season estimates were 2.28% lower than post season estimates. Monitored escapement were even closer although no independent estimate is available to check corrections for systems not counted. In addition, at the

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present no evaluation of the error associated with estimating residual fish in the district has been conducted. This analysis is beyond the scope of this paper as the procedure encompasses detailed modeling and simulation testing requiring a significant time commitment. However, this task should be completed before significant modifications to test fishing or data analysis procedures which could result in increased project cost are made.

Calculation of Passage Rate

During 1988 and in previous years data a pattern of fluctuating passage rates has been observed, with peak passage rates occurring at the mid-point of the return. In 1988 the peak passage rate was 29.1% higher than the calculated rate for the season. When these inflated passage rates are combined with the estimate of total CPUE points, nearly half the error in the total return in-season estimate can be accounted for. Obviously, if the test fishery was capturing fish in proportion to abundance the passage rate should be constant throughout the season.

Variability in passage rate could be explained by error associated with the estimate of fish in the district. Reported commercial harvest and escapement figures appeared relatively accurate, but procedures for estimating residual fish in the district have not been tested.

It is also probable that the sampling power of the test fishery is significantly influencing the results. Because of time limitation and cost, the vessel samples each station under a variety of different environmental conditions, each of which may impact catch. Daily catch reflected fairly substantial variation from day to day. For example, on 2 July the daily CPUE was 18.2 and one day latter it measured 93.6. In addition, the alternate day sampling schedule may be impacting run timing estimates.

Present methodology uses the most recent estimate of passage rate and total estimated CPUE to calculate total return. It may be more accurate to use an average passage rate calculated from each previous estimate. For example, in 1988 four estimates of passage rate were made from 8-15 July (Table 9). The average of these four estimates was 7,149 fish compared to the post season average of 6,933 fish. Utilizing the average figure the estimate of total return on 15 July would have been 13.8 million fish instead of 17.3 million. This factor needs further investigation as the results of the 1988 study may be coincidence.

Curve Selection Procedure

The procedure used to select the total CPUE for the season requires one to make an initial estimate of total CPUE for the season. This conflict in logic is difficult to explain other than the curve fitting procedure uses proportions for comparison. Thus the present procedure is to calculate an estimate of total CPUE from the historical proportions for each year of record and select the best statistical fit to present year data. Inherent in this procedure are the

assumptions that the historical data represents the actual entry of fish into the inlet and that the starting date of the project encompasses the entire run.

It is impossible to assess the first assumption as no independent estimate of entry pattern is available (fish tend to hold in fishing district so commercial harvest data are not indicative of entry). The second assumption that 24 June is a reasonable starting date is questionable. Historical data indicated that up to 11% of the sockeye salmon return could be pass the transect by that date (Hilsinger 1988). Unfortunately, the curve selection procedure treats day 1 of the present year return as 24 June. This translates into making average or early returns appear to be late returns.

A hypothetical example may illustrate this point. Assume that on 24 June in Year X the test fishery captures 10 sockeye salmon and this represents 10 CPUE points. Using present procedures each historical year (in this example Year 1 and 2) will estimate a total CPUE. Year 1 (an early year; 20% of return in the inlet by 24 June) and Year 2 (a late year; entry starts on 24 June) estimate 100 and 200 CPUE points, respectively. Calculated proportions for Year X would be 0.1 and 0.05 for a run starting on 24 June. Now assume that for Year X the return was early and on 24 June 10% of the return was in the inlet and the total CPUE for Year X will be 125 CPUE points. Therefore, had the test fishery started at the beginning of the return, an additional 12.5 CPUE points would have been collected. Thus the cumulative CPUE would have been 22.5 CPUE points and a proportion of 0.225 and 0.1125 for Year 1 and 2. Unfortunately, the curve fitting procedure treats the historical data base and present year in different manners. The present year return (Year X) starts on 24 June and makes a comparsion to the historical data base which may start earlier. Therefore the comparsion would be:

Year 1 - estimated proportion 0.1
historical proportion 0.2

Year 2 - estimated proportion 0.05
historical proportion 0.05

The early return, or Year 1, would not be selected as the best fit because the differential between the estimated proportion and historical proportion was greater than Year 2. The estimated total CPUE would be 200 in this case.

If fishing had started at the beginning of the return and the curve fitting procedure treated the data bases the same the following results would have been recorded:

Year 1 - estimated proportion 0.225
historical proportion 0.2

Year 2 - estimated proportion 0.1125
historical proportion 0.05

In this case Year 1 would be selected as the best fit and the estimate of total CPUE would be 100 CPUE points.

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This factor was evident in the 1988 results. The year of best fit through the early portion of the return was 1987, the latest return on record. However, post season results indicated that the return was one day early relative to historical averages (Table 10). As a consequence, the total CPUE estimates were high by a factor of 96.4% on 8 July and decreased to 2.1% on 29 July (Table 8). This would be expected because the influence of the early data points is reduced as additional data points are gathered with time.

Recommendations

The above factors need detailed evaluation if the present project is to continue to advance toward meeting the stated objective. The purpose of this report was only to present the 1988 project results. In this context, the following recommendations are made: 1) detailed analysis of the historical data base should be made to define if the factors influencing the 1988 results are consistent; 2) the test fishery should start as early as possible to encompass the entire sockeye salmon return; 3) average passage rates should be calculated and incorporated into the estimation procedure; and 4) an evaluation of daily exploitation rates in the commercial fisheries should be made.

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Table 1. Summary of sockeye salmon fishing effort, daily and cumulative catch, and daily and cumulative CPUE, Upper Cook Inlet offshore test fish project, 1988.

Date	No. of Stat.	MFT[a] (min)	Catch		CPUE		Mean Length (mm)
			Daily	Accum.	Daily	Accum.	
01-Jul	6	227.5	29.0	29.0	22.0	22.0	547
02-Jul	5	194.0	23.0	52.0	18.2	40.2	565
03-Jul	6	248.5	156.0	208.0	93.6	133.8	558
04-Jul	5	202.0	70.0	278.0	48.9	182.8	556
05-Jul	6	232.5	66.0	344.0	44.9	227.7	552
06-Jul	5	194.0	79.0	423.0	53.8	281.4	585
07-Jul	6	219.5	9.0	432.0	7.3	288.7	565
08-Jul	5	195.5	66.0	498.0	48.1	336.9	579
09-Jul	4	154.5	31.0	529.0	29.5	366.3	566
10-Jul	3	114.0	14.0	543.0	15.2	381.5	551
11-Jul	5	199.5	87.0	630.0	61.2	442.7	578
12-Jul	4	152.5	27.0	657.0	19.8	462.5	587
13-Jul	6	227.0	26.0	683.0	20.0	482.5	576
14-Jul	5	193.5	33.0	716.0	25.7	508.2	572
15-Jul	6	247.0	130.0	846.0	87.3	595.5	576
16-Jul	1	32.5	56.0	902.0	83.7	679.2	
17-Jul	6	237.5	117.0	1019.0	78.7	757.9	590
18-Jul	5	220.0	36.0	1055.0	26.2	784.1	578
19-Jul	6	225.0	14.0	1069.0	10.9	795.0	588
20-Jul	5	194.0	21.0	1090.0	15.6	810.6	580
21-Jul	3	100.0	47.0	1137.0	54.8	865.4	580
22-Jul	4	158.5	24.0	1161.0	17.9	883.3	543
23-Jul	3	120.5	34.0	1195.0	31.3	914.6	576
24-Jul	5	195.5	41.0	1236.0	30.7	945.3	582
25-Jul	6	230.0	48.0	1284.0	33.6	978.9	577
26-Jul	2	76.5	13.0	1297.0	26.7	1005.6	577
27-Jul	6	216.0	65.0	1362.0	52.3	1057.9	553
28-Jul	5	185.5	25.0	1387.0	19.2	1077.1	564
29-Jul	6	219.5	18.0	1405.0	16.7	1093.8	583
30-Jul	5	182.0	35.0	1440.0	37.4	1131.2	

[a] Mean fishing time.

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Table 2. Summary of sockeye salmon catch by date and station, Upper Cook Inlet offshore test fish project, 1988.

	Station Number								
Date	2	3	4	5	6	7	8	9	Total
01-Jul	0		0	19	0	9	1		29
02-Jul		1		8	11	0		3	23
03-Jul	8		0	10	114	24	0		156
04-Jul		2		0	11	51		6	70
05-Jul	0		3	1	60	2	0		66
06-Jul		0		1	61	17		0	79
07-Jul	0		1	4	3	1	0		9
08-Jul		2		24	36	3		1	66
09-Jul	0		0	8	15	5	3		31
10-Jul		0		11	0	3		0	14
11-Jul	1		35	48	3	0			87
12-Jul				23	1	0		3	27
13-Jul	0		1	3	6	14	2		26
14-Jul		0		5	7	21		0	33
15-Jul	15		2	32	28	53	0		130
16-Jul		0		0	0	56		0	56
17-Jul	0		3	10	74	27	3		117
18-Jul		1		17	15	3		0	36
19-Jul	1		0	5	4	2	2		14
20-Jul		0		9	9	3		0	21
21-Jul	0		21	26	0	0	0		47
22-Jul		1		11	6	6		0	24
23-Jul	6		6	22	0	0	0		34
24-Jul		16		19	4	1		1	41
25-Jul	0		3	1	3	37	4		48
26-Jul		0		0	0	11		2	13
27-Jul	8		5	3	5	23	21		65
28-Jul		10		13	1	0		1	25
29-Jul	1		0	3	5	2	7		18
30-Jul		0		0	6	11		18	35
Total	40	33	80	336	488	385	43	35	1440
%	2.8	2.3	5.6	23.3	33.9	26.7	3.0	2.4	100.0

Table 3. Summary of sockeye salmon CPUE by date and station, Upper Cook Inlet offshore test fish project, 1988.

	Station Number								
Date	2	3	4	5	6	7	8	9	Total
01-Jul	0.0			14.4	0.0	6.8	0.8		22.0
02-Jul		0.8		5.6	9.3	0.0		2.5	18.2
03-Jul	6.2		0.0	7.1	62.7	17.6	0.0		93.6
04-Jul		1.6		0.0	8.2	34.4		4.8	48.9
05-Jul	0.0		2.6	0.7	40.0	1.6	0.0		44.9
06-Jul		0.0		0.8	40.2	12.8		0.0	53.8
07-Jul	0.0		0.8	3.2	2.5	0.8	0.0		7.3
08-Jul		1.6		17.4	26.0	2.3		0.8	48.1
09-Jul	0.4		5.1	6.2	11.5	3.8	2.4		29.5
10-Jul		2.8		8.3	0.0	2.4		1.6	15.2
11-Jul	0.8		25.3	32.7	2.3	0.0			61.2
12-Jul				16.6	0.8	0.0		2.4	19.8
13-Jul	0.0		0.8	2.4	4.7	10.5	1.7		20.0
14-Jul		0.0		3.9	5.6	16.1		0.0	25.7
15-Jul	12.7		1.6	22.1	19.1	31.8	0.0		87.3
16-Jul		0.0		8.0	24.0	51.7		0.0	83.7
17-Jul	0.0		2.5	8.1	46.3	19.5	2.3		78.7
18-Jul		0.8		12.6	10.6	2.2		0.0	26.2
19-Jul	0.8		0.0	3.7	3.1	1.6	1.7		10.9
20-Jul		0.0		6.8	6.4	2.4		0.0	15.6
21-Jul	0.0		14.8	18.6	11.0	10.4	0.0		54.8
22-Jul		0.8		8.0	4.7	4.4		0.0	17.9
23-Jul	4.5		4.8	15.4	4.0	2.6	0.0		31.3
24-Jul		12.1		13.9	3.1	0.8		0.8	30.7
25-Jul	0.0		2.3	0.8	2.3	24.9	3.2		33.6
26-Jul		10.0		1.6	5.5	8.1		1.6	26.7
27-Jul	6.6		3.8	2.4	8.6	15.2	15.8		52.3
28-Jul		7.9		9.6	0.8	0.0		0.8	19.2
29-Jul	0.8		0.0	2.5	4.0	1.7	7.7		16.7
30-Jul		0.0		0.0	6.7	11.3		19.5	37.4
Total	32.8	38.5	64.4	253.6	373.9	297.8	35.4	34.7	1131.2
%	2.9	3.4	5.7	22.4	33.1	26.3	3.1	3.1	100.0

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Table 4. Summary of observed daily and cumulative sockeye salmon CPUE and daily and cumulative percent of total season CPUE, Upper Cook Inlet offshore test fish project, 1988.

Date	CPUE		Percentage[a]	
	Daily	Cumulative	Daily	Cumulative
24-Jun	6.00	6.00	0.49	0.49
25-Jun	7.01	13.01	0.57	1.06
26-Jun	8.01	21.02	0.65	1.72
27-Jun	9.26	30.28	0.76	2.47
28-Jun	10.52	40.80	0.86	3.33
29-Jun	12.02	52.82	0.98	4.31
30-Jun	13.77	66.59	1.12	5.43
01-Jul	22.00	88.59	1.79	7.23
02-Jul	18.20	106.79	1.48	8.71
03-Jul	93.60	200.39	7.63	16.35
04-Jul	48.90	249.29	3.99	20.33
05-Jul	44.90	294.19	3.66	24.00
06-Jul	53.80	347.99	4.39	28.38
07-Jul	7.30	355.29	0.60	28.98
08-Jul	48.10	403.39	3.92	32.90
09-Jul	29.50	432.89	2.41	35.31
10-Jul	15.20	448.09	1.24	36.55
11-Jul	61.20	509.29	4.99	41.54
12-Jul	19.80	529.09	1.62	43.16
13-Jul	20.00	549.09	1.63	44.79
14-Jul	25.70	574.79	2.10	46.88
15-Jul	87.30	662.09	7.12	54.00
16-Jul	83.70	745.79	6.83	60.83
17-Jul	78.70	824.49	6.42	67.25
18-Jul	26.20	850.69	2.14	69.39
19-Jul	10.90	861.59	0.89	70.28
20-Jul	15.60	877.19	1.27	71.55
21-Jul	54.80	931.99	4.47	76.02
22-Jul	17.90	949.89	1.46	77.48
23-Jul	31.30	981.19	2.55	80.03
24-Jul	30.70	1011.89	2.50	82.54
25-Jul	33.60	1045.49	2.74	85.28
26-Jul	26.70	1072.19	2.18	87.45
27-Jul	52.30	1124.49	4.27	91.72
28-Jul	19.20	1143.69	1.57	93.29
29-Jul	16.70	1160.39	1.36	94.65
30-Jul	37.40	1197.79	3.05	97.70

[a] Percentage is based on total season CPUE of 1226. Data from 24 June to 30 June estimated from 1985 run timing model.

Table 5. Estimated sockeye salmon escapement recorded during the fishing season, Upper Cook Inlet, Alaska, 1988.[a]

Date	Escapement					
	Kasilof	Kenai	Yentna	Crescent	Fish Cr.	Total
< 14-Jun	1300					1300
15-Jun	781					781
16-Jun	698					698
17-Jun	459					459
18-Jun	497					497
19-Jun	507					507
20-Jun	673					673
21-Jun	860					860
22-Jun	1218					1218
23-Jun	1088					1088
24-Jun	1816					1816
25-Jun	1803					1803
26-Jun	1805					1805
27-Jun	2505					2505
28-Jun	4178					4178
29-Jun	3585					3585
30-Jun	2429					2429
01-Jul	1728	214		490		2432
02-Jul	741	169		1682		2592
03-Jul	1072	270		6456		7798
04-Jul	4246	290		4261		8797
05-Jul	1558	544		2630		4732
06-Jul	3146	664		4011		7821
07-Jul	7667	417	202	3769		12055
08-Jul	3544	237	185	4846	1	8813
09-Jul	7982	486	251	3843	73	12635
10-Jul	11401	7939	188	1525	291	21344
11-Jul	7581	53012	168	987	2	61750
12-Jul	9110	26069	168	1558	0	36905
13-Jul	4991	53630	166	1736	2	60525
14-Jul	2153	45234	197	1934	106	49624
15-Jul	6897	37567	297	194	2572	47527
16-Jul	2525	53789	172	332	647	57465
17-Jul	2257	28830	199	1153	488	32927
18-Jul	1880	38409	190	1739	940	43158
19-Jul	2980	35297	2305	1379	301	42262
20-Jul	7236	34600	5567	549	7336	55288
21-Jul	13246	55523	3806	1552	9295	83422
22-Jul	9643	107439	1787	1148	12954	132971

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Table 5. (p 2 of 2)

	Escapement					
Date	Kasilof	Kenai	Yentna	Crescent	Fish Cr.	Total
23-Jul	1397	112284	3743	1456	5891	124771
24-Jul	782	66915	5704	1833	590	75824
25-Jul	650	42321	7628	1873	23	52495
26-Jul	709	26958	7366	1353	166	36552
27-Jul	656	15256	2616	1078	0	19606
28-Jul	802	9084	1949	321	0	12156
29-Jul	919	8348	1492	654	109	11522
30-Jul	354	2908	1530	731	678	6201
31-Jul	499	3591	1110	644	4152	9996
01-Aug	728	4356	516		1317	6917
02-Aug	550	5017	710		2299	8576
Total	147832	877667	50212	57717	50233	1183661

[a] These data were recorded prior to final post season processing of the data. Therefore numbers may differ slightly from final escapement numbers. These data are presented for re-creation of offshore test fish results only and are not to be used for final daily escapement estimates.

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Table 6. Estimated sockeye salmon harvest and total return recorded during the 1988 fishing season, Upper Cook Inlet, Alaska.[a]

Date	Catch				Total Return[b]	
	Personal Use	Northern	Central	Total Catch	Total Day	Accum.
14-Jun		1684		1684	2984	2984
15-Jun					781	3765
16-Jun					698	4463
17-Jun			318	318	777	5240
18-Jun					497	5737
19-Jun					507	6244
20-Jun		141	510	651	1324	7568
21-Jun	916			916	1776	9344
22-Jun	1999			1999	3217	12561
23-Jun	1556			1556	2644	15205
24-Jun	2154		908	3062	4878	20083
25-Jun	2053			2053	3856	23939
26-Jun	1125			1125	2930	26869
27-Jun		966	38271	39237	41742	68611
28-Jun					4178	72789
29-Jun					3585	76374
30-Jun					2429	78803
01-Jul		817	147308	148125	150557	229360
02-Jul					2592	231952
03-Jul					7798	239750
04-Jul		1016	219350	220366	229163	468913
05-Jul					4732	473645
06-Jul					7821	481466
07-Jul					12055	493521
08-Jul		1223	430263	431486	440299	933820
09-Jul			4728	4728	17363	951183
10-Jul			141007	141007	162351	1113534
11-Jul		7132	950222	957354	1019104	2132638
12-Jul			100849	100849	137754	2270392
13-Jul			288740	288740	349265	2619657
14-Jul			5056	5056	54680	2674337
15-Jul		5804	866207	872011	919538	3593875
16-Jul			383037	383037	440502	4034377
17-Jul			465557	465557	498484	4532861
18-Jul		20616	544058	564674	607832	5140693
19-Jul			139531	139531	181793	5322486
20-Jul			3757	3757	59045	5381531
21-Jul			130071	130071	213493	5595024
22-Jul		30021	592119	622140	755111	6350135

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Table 6. (p. 2 of 2)

Date	Catch				Run	
	Personal Use	Northern	Central	Total Catch	Total Day	Accum.
23-Jul			211829	211829	336600	6686735
24-Jul		4206	189566	193772	269596	6956331
25-Jul		3902	122359	126261	178756	7135087
26-Jul		6810	136893	143703	180255	7315342
27-Jul		5201	56036	61237	80843	7396185
28-Jul		6139	76200	82339	94495	7490680
29-Jul		12241	144828	157069	168591	7659271
30-Jul			25460	25460	31661	7690932
31-Jul			21168	21168	31164	7722096
01-Aug		1844	44649	46493	53410	7775506
02-Aug					8576	7784082
Total	9803	109763	6480855	6600421	7784082	

[a] These data were recorded prior to final post season processing of the data. Therefore numbers may differ slightly from final harvest and total return estimates. These data are presented for re-creation of offshore test fish results only and are not to be used for final harvest estimates.

[b] Total return is total harvest and escapement (from Table 5).

ACE 6208744

Table 7. Total offshore test fish CPUE and the total sockeye salmon return estimates made during the 1988 Upper Cook Inlet, Alaska salmon fishing season.

Date	Accum. CPUE[a]	Best Fit Year	MSSDEV[b]	Passage Rate	Total CPUE	Return to Date ($\times 10^6$)	Total Return Estimate ($\times 10^6$)
08-Jul	288.7	1987	0.000415	5,168	2,408	1.492	12.4
12-Jul	442.7	1987	0.000438	7,886	2,159	3.491	17.0
13-Jul	488.7	1987	0.000753	6,589	1,992	3.22[c]	13.1
15-Jul	514.4	1987	0.000816	8,952	1,937	4.605	17.3
17-Jul	685.4	1982	0.000805	7,345	1,510	5.034	11.1
19-Jul	784.1	1982	0.000815	7,624	1,482	5.978	11.3
29-Jul	1077.1	1985	0.000940	7,431	1,252	8.004	9.3

[a] Accumulated CPUE recorded from start of test fishery to day prior to date of estimate of total CPUE.
[b] Mean sum of squared deviation.
[c] Adjusted total return to date lower than previous day because of adjustments to reported harvest.

ACE 6208745

Table 8. Estimates of relative error associated with the total CPUE and total sockeye salmon return predictions made by the Upper Cook Inlet, Alaska offshore test fish project, 1988.

	CPUE[a]			Total Return[b]		
Date	Percent of Migration	Estimate of Total	Relative Error (%)	Percent of Migration	Estimate of Total	Relative Error (%)
08-Jul	23.5	2,408	96.4	16.6	12.4	37.8
12-Jul	36.1	2,159	76.1	38.8	17.0	88.9
13-Jul	39.9	1,992	62.5	37.0	13.1	45.6
15-Jul	42.0	1,937	58.0	51.2	17.3	92.2
17-Jul	55.9	1,510	23.2	55.9	11.1	23.3
19-Jul	64.0	1,482	20.9	66.4	11.3	25.6
29-Jul	87.9	1,252	2.1	88.9	9.3	3.3

[a] Total CPUE for season was 1,226.
[b] Total sockeye salmon return was 9.0 million fish.

ACE 6208746

Table 9. Estimates of sockeye salmon catchability, passage rate, and the relative error of those estimates, Upper Cook Inlet, Alaska offshore test fish project, 1988.

Date	Catchability[a]		Passage Rate[b]	
	q	Relative Error (%)	$\frac{1}{q}$	Relative Error (%)
08-Jul	0.000193	34.4	5,168	-25.5
12-Jul	0.000127	-11.9	7,886	13.7
13-Jul	0.000152	5.4	6,589	-5.0
15-Jul	0.000112	-22.4	8,952	29.1
17-Jul	0.000136	-5.5	7,345	5.9
19-Jul	0.000131	-8.9	7,624	10.0
29-Jul	0.000135	-6.5	7,431	7.2

[a] Catchabilty (q) for 1988 was 0.000144.
[b] Passage rate for 1988 was 6933 fish. Passage rate was calculated using a total sockeye return pass the transect of 8.5 million fish. An additional 0.5 million fish were harvested prior to the transect for a total return to Upper Cook Inlet of 9.0 million.

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Table 10. Mean date of the sockeye salmon return across Anchor Point transect by year, Upper Cook Inlet, Alaska offshore test fish project.

Year	Mean Date[a] (t)	Calendar Date
1979	18.47	July 11
1980	22.71	July 15
1981	13.72	July 6
1982	24.20	July 17
1983	22.69	July 15
1984	18.47	July 11
1985	22.71	July 15
1986	23.07	July 16
1987	25.72	July 18
1988	20.60	July 13
1979-1986	18.45	July 11
1979-1987	21.31	July 14

[a] Day (t) 1 = June 24.

ACE 6208748

Table 11. Comparsion of inseason and postseason commercial sockeye salmon harvest estimates for Upper Cook Inlet, Alaska 1988.

Date	Post Season Commercial Harvest	Inseason Commercial Harvest	Difference	Percent Error
14-Jun	1790	1684	-106	-5.92%
17-Jun	339	318	-21	-6.19%
20-Jun	708	651	-57	-8.05%
24-Jun	995	908	-87	-8.74%
27-Jun	86448	39237	-47211	-54.61%
01-Jul	190264	148125	-42139	-22.15%
04-Jul	202343	220366	18023	8.91%
08-Jul	435070	431486	-3584	-0.82%
09-Jul	10582	4728	-5854	-55.32%
10-Jul	153511	141007	-12504	-8.15%
11-Jul	926988	957354	30366	3.28%
12-Jul	125249	100849	-24400	-19.48%
13-Jul	314463	288740	-25723	-8.18%
14-Jul	5739	5056	-683	-11.90%
15-Jul	866553	872011	5458	0.63%
16-Jul	361154	383037	21883	6.06%
17-Jul	468483	465557	-2926	-0.62%
18-Jul	553957	564674	10717	1.93%
19-Jul	144497	139531	-4966	-3.44%
20-Jul	3455	3757	302	8.74%
21-Jul	135246	130071	-5175	-3.83%
22-Jul	624824	622140	-2684	-0.43%
23-Jul	235870	211829	-24041	-10.19%
24-Jul	183497	193772	10275	5.60%
25-Jul	131094	126261	-4833	-3.69%
26-Jul	147454	143703	-3751	-2.54%
27-Jul	63140	61237	-1903	-3.01%
28-Jul	80926	82339	1413	1.75%
29-Jul	169804	157069	-12735	-7.50%
30-Jul	24247	25460	1213	5.00%
31-Jul	27639	21168	-6471	-23.41%
01-Aug	47229	46493	-736	-1.56%
Total	6,723,558	6,590,618	-132,940	-2.28

ACE 6208749

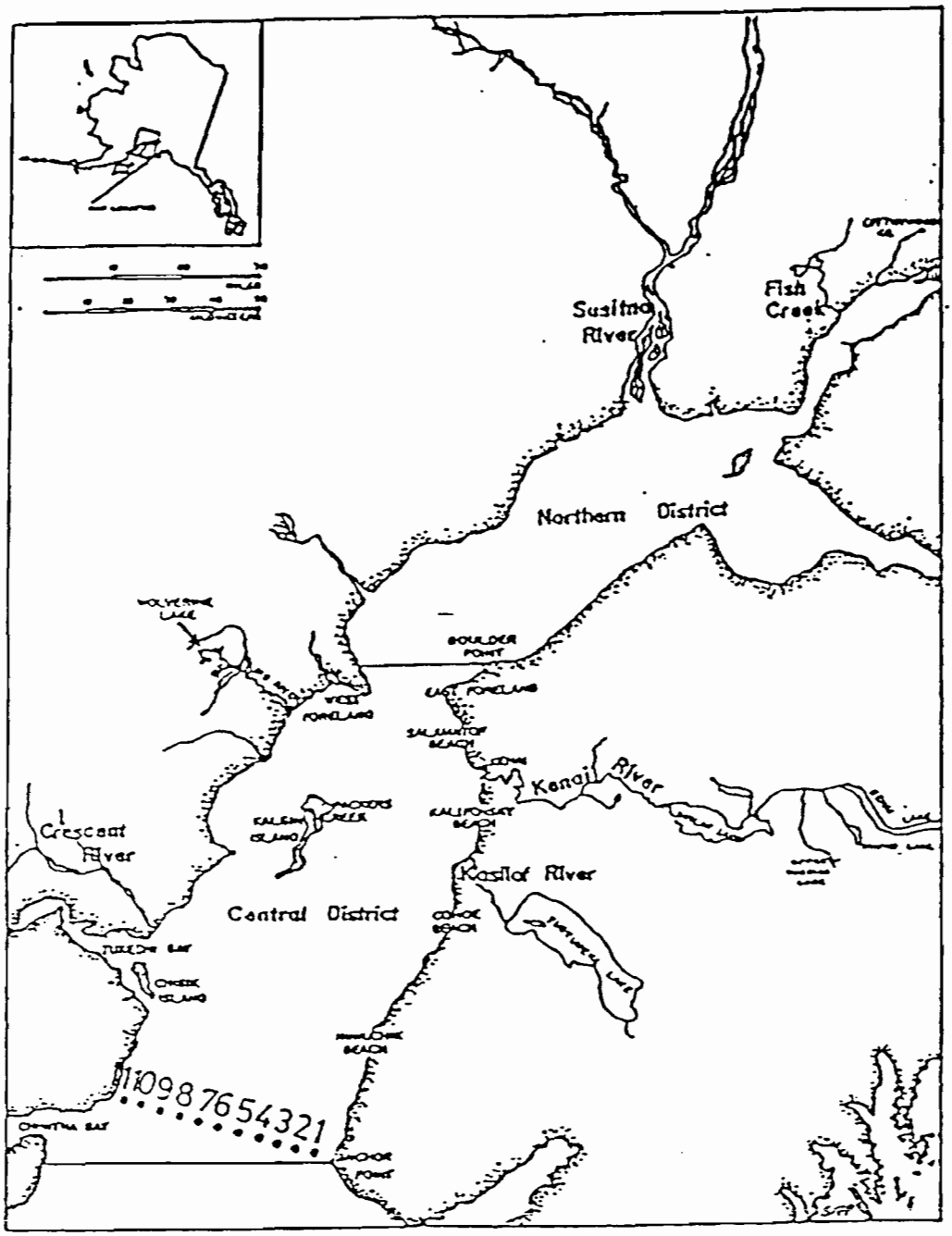

Figure 1. Map of Upper Cook Inlet, Alaska, showing location of Offshore Test Fish transect.

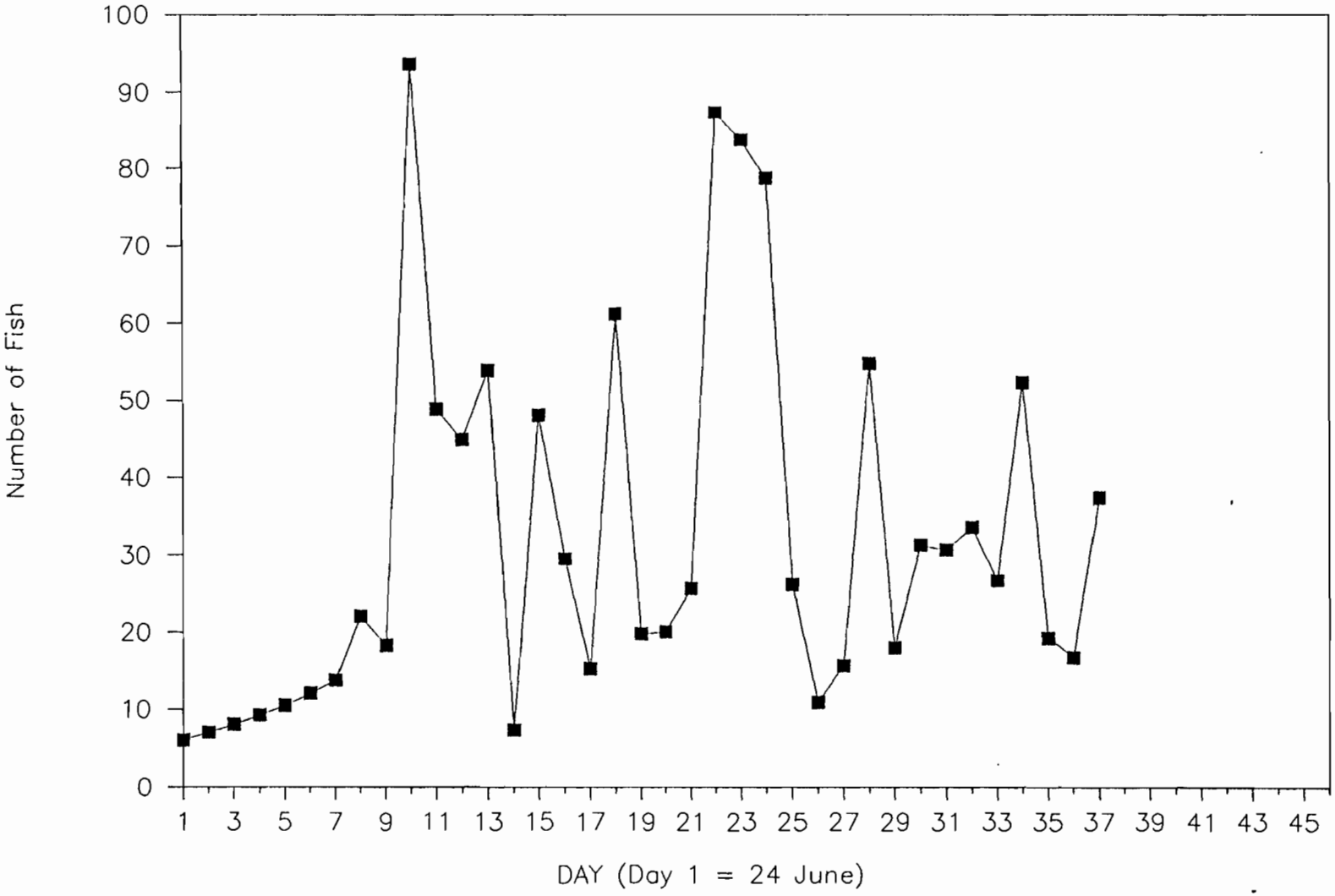

Figure 2. Daily CPUE for sockeye salmon recorded during the 1988 Offshore Test Fish project, Upper Cook Inlet, Alaska.

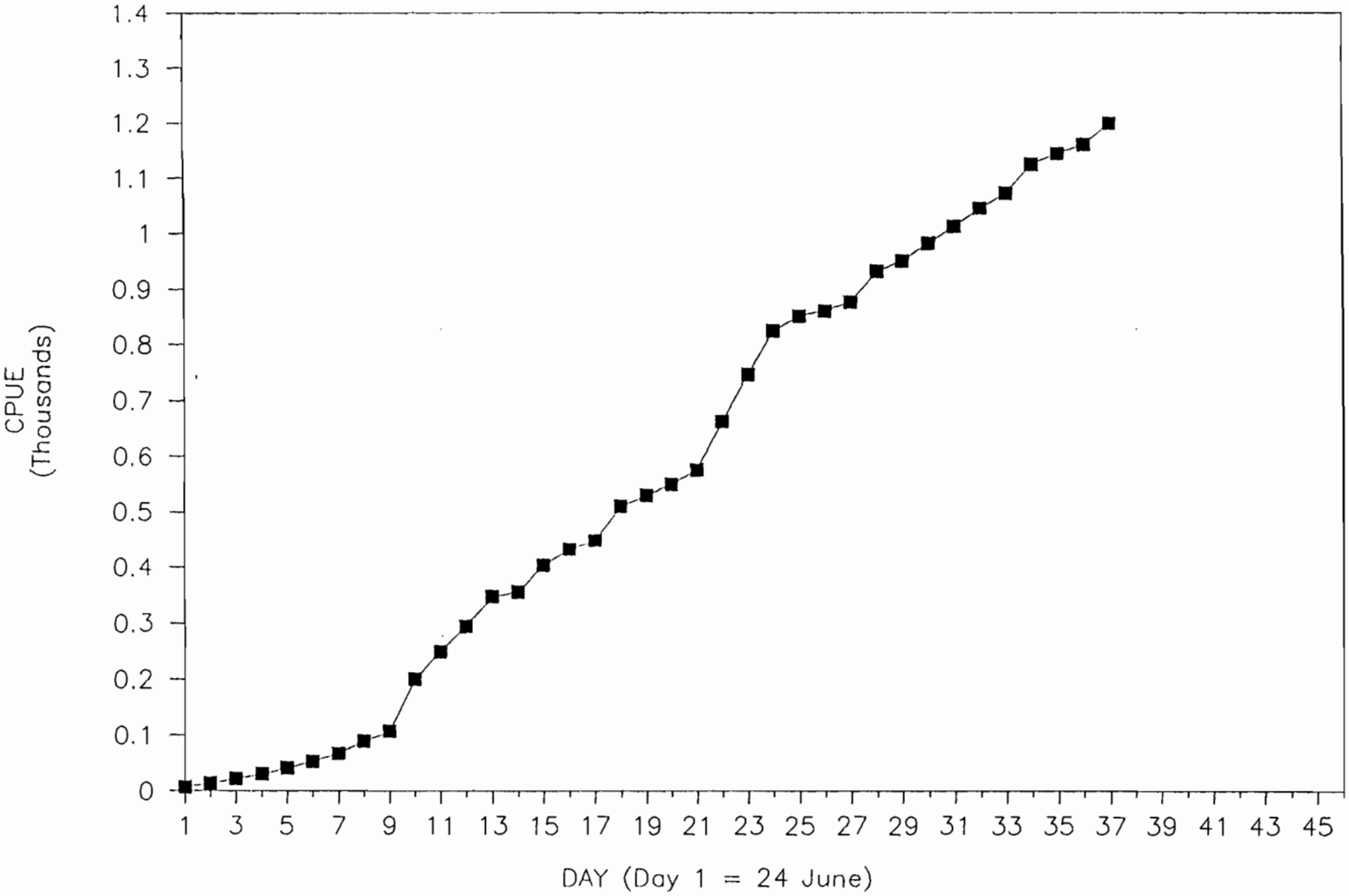

Figure 3. Cumulative CPUE for sockeye salmon recorded during the 1988 Offshore Test Fish project, Upper Cook Inlet, Alaska.

ACE 6208752

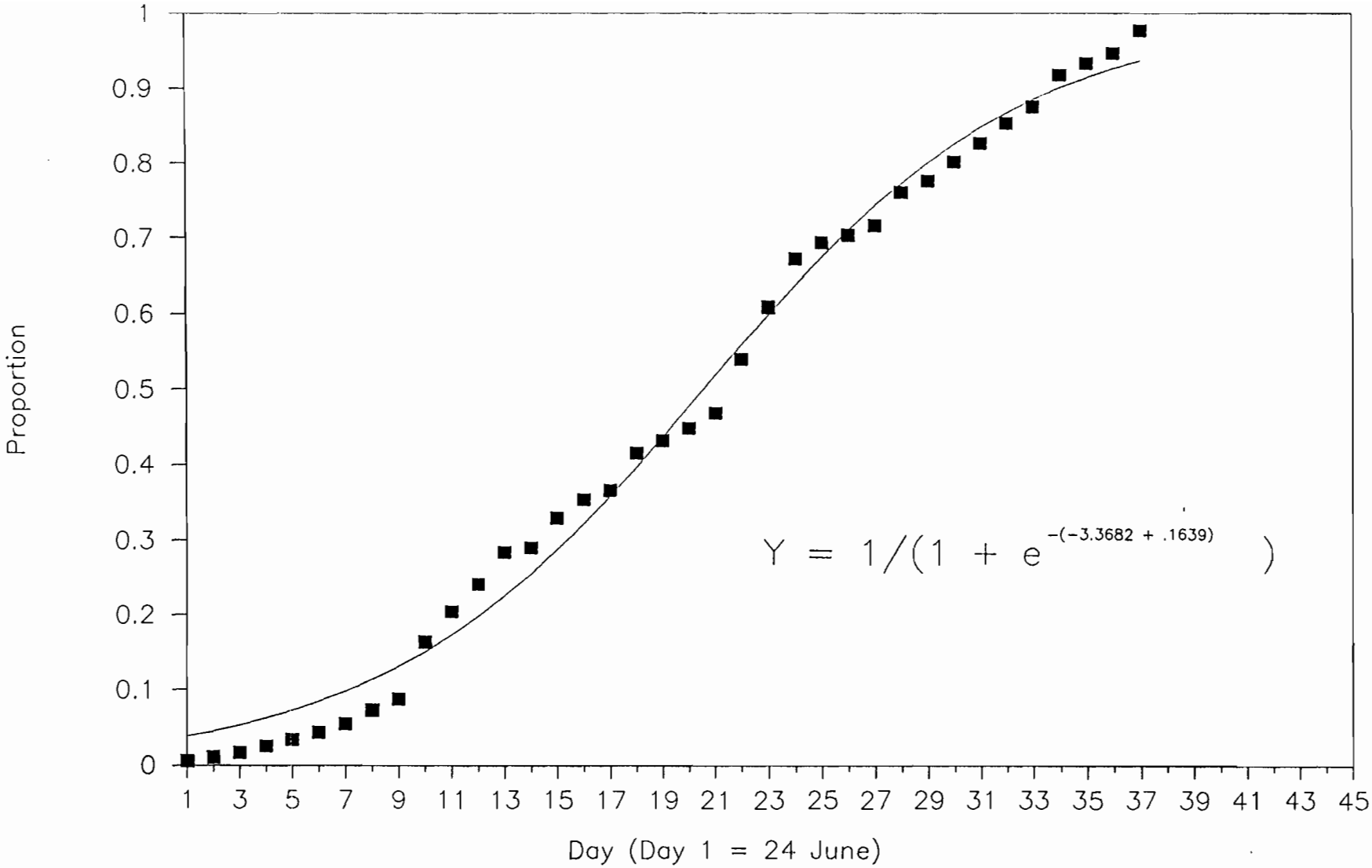

Figure 4. Cumulative proportions estimated for the sockeye salmon return to Upper Cook Inlet, Alaska, in 1988.

ACE 6208753

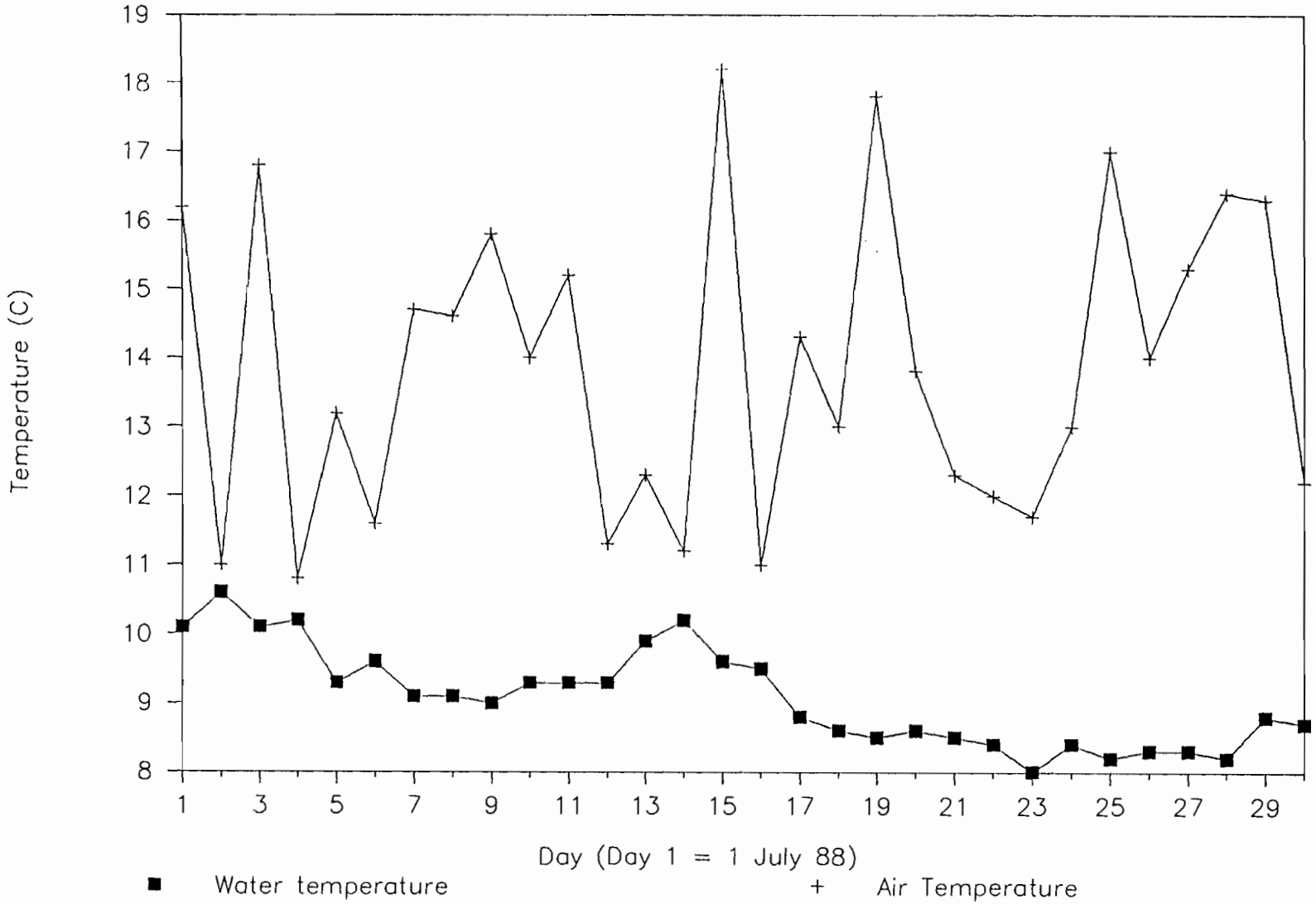

Figure 5. Water and air temperatures measured in Upper Cook Inlet, Alaska, during the Offshore Test Fish project, 1988.

ACE 6208754

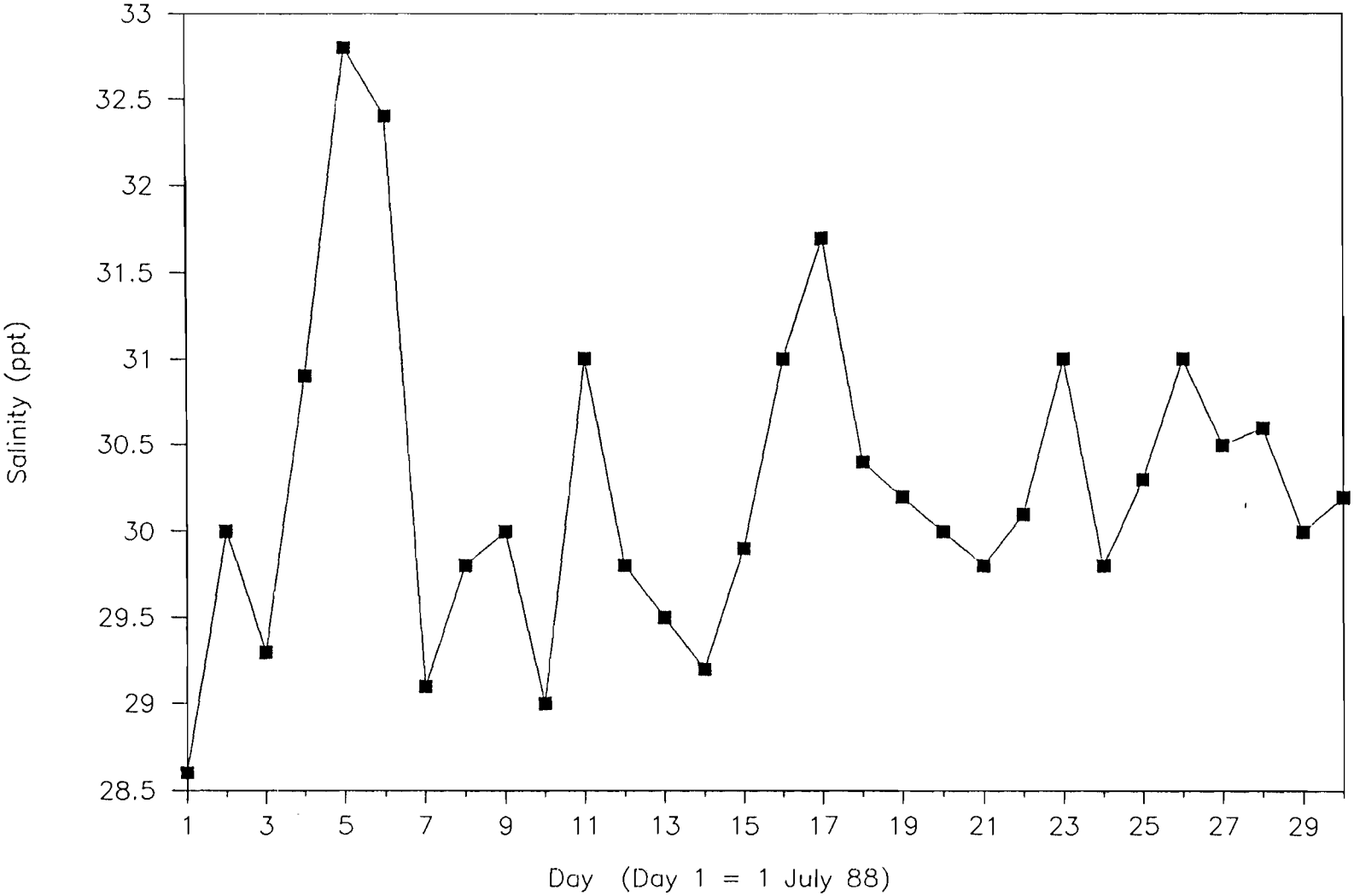

Figure 6. Salinity measured in Upper Cook Inlet, Alaska, during the Offshore Test Fish project, 1988.

ACE 6208755

Appendix A. Summary of pink salmon fishing effort, daily and cumulative catch, and daily and cumulative CPUE, Upper Cook Inlet offshore test fish project, 1988.

Date	No. of Stat.	MFT[a] (min)	Catch		CPUE	
			Daily	Accum.	Daily	Accum.
01-Jul	6	227.5	0.0	0.0	0.0	0.0
02-Jul	5	194.0	0.0	0.0	0.0	0.0
03-Jul	6	248.5	0.0	0.0	0.0	0.0
04-Jul	5	202.0	0.0	0.0	0.0	0.0
05-Jul	6	232.5	0.0	0.0	0.0	0.0
06-Jul	5	194.0	1.0	1.0	0.8	0.8
07-Jul	6	219.5	0.0	1.0	0.0	0.8
08-Jul	5	195.5	1.0	2.0	0.8	1.6
09-Jul	4	154.5	0.0	2.0	0.0	1.6
10-Jul	3	114.0	0.0	2.0	0.0	1.6
11-Jul	5	199.5	1.0	3.0	0.7	2.3
12-Jul	4	152.5	1.0	4.0	0.7	3.0
13-Jul	6	227.0	1.0	5.0	0.8	3.8
14-Jul	5	193.5	2.0	7.0	1.6	5.4
15-Jul	6	247.0	12.0	19.0	8.0	13.4
16-Jul	1	32.5	0.0	19.0	0.0	13.4
17-Jul	6	237.5	8.0	27.0	5.7	19.1
18-Jul	5	220.0	2.0	29.0	1.6	20.7
19-Jul	6	225.0	2.0	31.0	1.5	22.2
20-Jul	5	194.0	3.0	34.0	2.2	24.5
21-Jul	3	100.0	0.0	34.0	0.0	24.5
22-Jul	4	158.5	3.0	37.0	2.2	26.7
23-Jul	3	120.5	4.0	41.0	3.0	29.7
24-Jul	5	195.5	1.0	42.0	0.8	30.4
25-Jul	6	230.0	8.0	50.0	6.3	36.7
26-Jul	2	76.5	1.0	51.0	0.7	37.5
27-Jul	6	216.0	17.0	68.0	14.1	51.5
28-Jul	5	185.5	5.0	73.0	4.0	55.5
29-Jul	6	219.5	2.0	75.0	2.0	57.5
30-Jul	5	182.0	7.0	82.0	7.4	64.9

[a] Mean fishing time.

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Appendix B. Summary of chum salmon fishing effort, daily and cumulative catch, and daily and cumulative CPUE, Upper Cook Inlet offshore test fish project, 1988.

Date	No. of Stat.	MFT[a] (min)	Catch		CPUE	
			Daily	Accum.	Daily	Accum.
01-Jul	6	227.5	3.0	3.0	2.3	2.3
02-Jul	5	194.0	25.0	28.0	19.7	22.0
03-Jul	6	248.5	14.0	42.0	8.8	30.8
04-Jul	5	202.0	13.0	55.0	9.2	40.0
05-Jul	6	232.5	6.0	61.0	4.0	44.0
06-Jul	5	194.0	13.0	74.0	9.1	53.1
07-Jul	6	219.5	9.0	83.0	7.4	60.4
08-Jul	5	195.5	12.0	95.0	8.9	69.3
09-Jul	4	154.5	19.0	114.0	14.6	83.9
10-Jul	3	114.0	6.0	120.0	4.6	88.5
11-Jul	5	199.5	16.0	136.0	12.2	100.7
12-Jul	4	152.5	12.0	148.0	9.1	109.8
13-Jul	6	227.0	25.0	173.0	19.3	129.1
14-Jul	5	193.5	12.0	185.0	9.4	138.5
15-Jul	6	247.0	53.0	238.0	32.5	170.9
16-Jul	1	32.5	33.0	271.0	30.5	201.4
17-Jul	6	237.5	34.0	305.0	22.9	224.3
18-Jul	5	220.0	71.0	376.0	51.0	275.3
19-Jul	6	225.0	17.0	393.0	13.0	288.3
20-Jul	5	194.0	66.0	459.0	47.6	335.9
21-Jul	3	100.0	18.0	477.0	12.8	348.7
22-Jul	4	158.5	29.0	506.0	21.3	370.0
23-Jul	3	120.5	21.0	527.0	14.9	384.9
24-Jul	5	195.5	22.0	549.0	16.3	401.2
25-Jul	6	230.0	34.0	583.0	23.4	424.5
26-Jul	2	76.5	11.0	594.0	8.2	432.7
27-Jul	6	216.0	39.0	633.0	31.1	463.8
28-Jul	5	185.5	5.0	638.0	3.8	467.6
29-Jul	6	219.5	2.0	640.0	1.9	469.5
30-Jul	5	182.0	43.0	683.0	45.1	514.6

[a] Mean fishing time.

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Appendix C. Summary of coho salmon fishing effort, daily and cumulative catch, and daily and cumulative CPUE, Upper Cook Inlet offshore test fish project, 1988.

Date	No. of Stat.	MFT[a] (min)	Catch		CPUE	
			Daily	Accum.	Daily	Accum.
01-Jul	6	227.5	1.0	1.0	0.8	0.8
02-Jul	5	194.0	4.0	5.0	3.2	4.0
03-Jul	6	248.5	3.0	8.0	2.0	6.0
04-Jul	5	202.0	11.0	19.0	7.5	13.5
05-Jul	6	232.5	4.0	23.0	2.7	16.2
06-Jul	5	194.0	3.0	26.0	2.1	18.3
07-Jul	6	219.5	7.0	33.0	5.7	24.0
08-Jul	5	195.5	2.0	35.0	1.5	25.5
09-Jul	4	154.5	2.0	37.0	1.6	27.0
10-Jul	3	114.0	13.0	50.0	9.9	36.9
11-Jul	5	199.5	18.0	68.0	12.6	49.5
12-Jul	4	152.5	6.0	74.0	4.4	54.0
13-Jul	6	227.0	15.0	89.0	11.6	65.6
14-Jul	5	193.5	7.0	96.0	5.4	71.0
15-Jul	6	247.0	9.0	105.0	6.0	77.1
16-Jul	1	32.5	0.0	105.0	0.0	77.1
17-Jul	6	237.5	24.0	129.0	16.4	93.5
18-Jul	5	220.0	11.0	140.0	7.9	101.4
19-Jul	6	225.0	20.0	160.0	15.3	116.6
20-Jul	5	194.0	18.0	178.0	13.0	129.7
21-Jul	3	100.0	8.0	186.0	5.7	135.4
22-Jul	4	158.5	24.0	210.0	17.6	153.0
23-Jul	3	120.5	12.0	222.0	8.6	161.6
24-Jul	5	195.5	10.0	232.0	7.7	169.3
25-Jul	6	230.0	20.0	252.0	14.4	183.7
26-Jul	2	76.5	11.0	263.0	8.2	191.9
27-Jul	6	216.0	27.0	290.0	20.3	212.2
28-Jul	5	185.5	24.0	314.0	17.9	230.1
29-Jul	6	219.5	0.0	314.0	0.0	230.1
30-Jul	5	182.0	8.0	322.0	8.3	238.4

[a] Mean fishing time.

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Appendix D. Summary of chinook salmon fishing effort, daily and cumulative catch, and daily and cumulative CPUE, Upper Cook Inlet offshore test fish project, 1988.

Date	No. of Stat.	MFT[a] (min)	Catch		CPUE	
			Daily	Accum.	Daily	Accum.
01-Jul	6	227.5	0.0	0.0	0.0	0.0
02-Jul	5	194.0	1.0	1.0	0.8	0.8
03-Jul	6	248.5	0.0	1.0	0.0	0.8
04-Jul	5	202.0	0.0	1.0	0.0	0.8
05-Jul	6	232.5	0.0	1.0	0.0	0.8
06-Jul	5	194.0	1.0	2.0	0.8	1.6
07-Jul	6	219.5	0.0	2.0	0.0	1.6
08-Jul	5	195.5	0.0	2.0	0.0	1.6
09-Jul	4	154.5	1.0	3.0	0.8	2.4
10-Jul	3	114.0	0.0	3.0	0.0	2.4
11-Jul	5	199.5	0.0	3.0	0.0	2.4
12-Jul	4	152.5	0.0	3.0	0.0	2.4
13-Jul	6	227.0	0.0	3.0	0.0	2.4
14-Jul	5	193.5	0.0	3.0	0.0	2.4
15-Jul	6	247.0	0.0	3.0	0.0	2.4
16-Jul	1	32.5	0.0	3.0	0.0	2.4
17-Jul	6	237.5	1.0	4.0	0.7	3.1
18-Jul	5	220.0	0.0	4.0	0.0	3.1
19-Jul	6	225.0	0.0	4.0	0.0	3.1
20-Jul	5	194.0	0.0	4.0	0.0	3.1
21-Jul	3	100.0	0.0	4.0	0.0	3.1
22-Jul	4	158.5	0.0	4.0	0.0	3.1
23-Jul	3	120.5	0.0	4.0	0.0	3.1
24-Jul	5	195.5	1.0	5.0	0.8	3.9
25-Jul	6	230.0	0.0	5.0	0.0	3.9
26-Jul	2	76.5	0.0	5.0	0.0	3.9
27-Jul	6	216.0	0.0	5.0	0.0	3.9
28-Jul	5	185.5	0.0	5.0	0.0	3.9
29-Jul	6	219.5	0.0	5.0	0.0	3.9
30-Jul	5	182.0	0.0	5.0	0.0	3.9

[a] Mean fishing time.

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Appendix E. Daily and cumulative proportions of the total sockeye salmon return to Upper Cook Inlet, Alaska in 1988.[a]

Day	Date	Daily	Culumative
1	624	0.039	0.039
2	625	0.0066	0.0456
3	626	0.0077	0.0533
4	627	0.0089	0.0622
5	628	0.0103	0.0725
6	629	0.0118	0.0843
7	630	0.0135	0.0979
8	701	0.0155	0.1133
9	702	0.0175	0.1309
10	703	0.0198	0.1506
11	704	0.0222	0.1728
12	705	0.0247	0.1975
13	706	0.0273	0.2248
14	707	0.0298	0.2546
15	708	0.0323	0.2869
16	709	0.0347	0.3216
17	710	0.0367	0.3584
18	711	0.0385	0.3968
19	712	0.0398	0.4366
20	713	0.0406	0.4773
21	714	0.0409	0.5182
22	715	0.0407	0.5589
23	716	0.0399	0.5988
24	717	0.0387	0.6375
25	718	0.037	0.6745
26	719	0.0349	0.7094
27	720	0.0326	0.742
28	721	0.0301	0.7721
29	722	0.0275	0.7996
30	723	0.025	0.8246
31	724	0.0225	0.847
32	725	0.02	0.8671
33	726	0.0178	0.8849
34	727	0.0157	0.9005
35	728	0.0137	0.9143
36	729	0.012	0.9263
37	730	0.0104	0.9360

[a] Proportions calculated from curve fitting of CPUE measured at Anchor Point transect of the Offshore Test Fish project.

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Appendix F. Chemical and physical observations made in Upper Cook Inlet, Alaska during the conduct of the 1988 offshore test fish project.

Date	Station	Air Temp. (C)	Water Temp. (C)	Wind Velocity (knots)	Wind Dir[a]	Tide Stage[b]	Salinity (ppt)	Water Depth (f)	Secchi (m)
July 1	2	18	9	0	0	3	28	24	6
1	4	14	11	0	0	2	29.5	24	6
1	5	16	10	0	0	4	29	48	3
1	6	17	10	0	0	4	28.5	46	2.5
1	7	15	10.5	0	0	4	28	47	3
1	8	17	10	2	7	4	28.5	26	3
2	9	11	10	13	6	3	28	21	2.5
2	7	11	11	15	5	3	31	44	3
2	6	11	11	18	5	3	30	46	4
2	5	11	10.5	22	5	3	30	32	5
2	3	11	10.5	14	6	3	31	24	5
3	2	15	10.5	5	5	3	29	26	7.5
3	4	18	10.5	5	5	3	29	22	8
3	5	17	10	5	5	2	28.5	42	3
3	6	18	10	8	6	2	29	48	3
3	7	17	9.5	12	6	4	30	48	3
3	8	16	10	10	6	4	30	31	2.5
4	9	9	10	3	4	4	30	21	1.5
4	7	10	10	13	4	4	31.5	46	1.5
4	6	10	10	17	4	4	31	48	4
4	5	11	10.5	17	4	4	30	39	7
4	3	14	10.5	20	4	3	32	19	7
5	2	11	10	5	6	1	32	29	9
5	4	13	10	0	0	3	30	24	9
5	5	14	9.5	0	0	3	32	33	6
5	6	15	9	5	6	3	33	47	3
5	7	13	9	5	6	4	34	45	3
5	8	13	8.3	6	6	4	36	32	3
6	9	10	10	4	2	4	34	20	1.5
6	7	11	9	0	0	4	34	45	2.5
6	6	12	9	0	0	4	35	44	4
6	5	14	10	0	0	4	30	36	8
6	3	11	10	0	0	1	29	24	9
7	2	12	10	0	0	1	29	20	9
7	4	12	9.5	3	5	3	29	26	9
7	5	15	10	0	0	3	28.5	39	8
7	6	18	8.5	0	0	3	29	47	4
7	7	16	8	0	0	3	29	44	3
7	8	15	8.5	0	0	2	30	26	3
8	9	11	9	7	5	4	30	19	1
8	7	12	8.5	10	5	4	30	44	2.5
8	6	18	9	14	6	4	29	46	3
8	5	18	9	10	6	4	30	50	4
8	3	14	10	5	4	4	30	21	9
9	5	18	9.5	10	5	4	29	47	3.5

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Date	Station	Air Temp. (C)	Water Temp. (C)	Wind Velocity (knots)	Wind Dir.	Tide Stage	Salinity (ppt)	Water Depth (f)	Secchi (m)
July 9	6	15	9	7	4	4	30	48	4
9	7	15	9	6	5	4	30	46	3.5
9	8	15	8.5	4	5	1	31	26	3
10	7	12	9.5	17	4	3	29	44	3
10	6	14	9.5	18	4	3	29	44	4
10	5	16	9	20	4	3	29	43	4
11	2	14	9.5	5	6	2	32	26	5
11	4	14	9.5	6	6	4	31	24	6
11	5	15	9.5	12	6	4	31	44	5
11	6	19	9	11	6	1	32	46	6
11	7	14	9	15	6	3	29	47	3.5
12	9	12	9	12	5	3	29	19	3
12	7	11	9	16	6	3	30	45	3
12	6	11	10	16	6	3	30	47	3
12	5	11	9	11	6	3	30	44	4
13	2	15	10	0	0	3	30	20	6
13	4	13	10	0	0	3	29	26	6
13	5	11	10	5	6	4	30	46	7
13	6	13	10	10	6	4	30	44	5
13	7	11	10	5	6	4	29	44	3
13	8	11	9.5	10	6	1	29	25	3.5
14	9	10	10	5	6	4	29	29	3
14	7	11	10	11	6	3	28	44	3.5
14	6	10	11	6	3	3	29	45	5
14	5	12	10	12	6	3	29	38	7
14	3	13	10	8	4	3	31	18	7
15	2	21	10	8	4	3	30	20	6
15	4	20	9.5	5	4	3	30	25	5
15	5	20	9	3	4	2	30	49	5
15	6	16	9.5	5	4	4	30	48	5
15	7	18	10	5	4	4	30	4	3
15	8	14	9.5	6	4	4	29.5	31	3
16	7	11	9.5	30	5	1	31	46	2
17	2	13	9.5	20	5	3	33	20	7
17	4	15	9	12	5	3	32	25	20
17	5	15	9	10	5	3	33	35	4
17	6	15	8.5	10	5	4	31	46	3
17	7	14	8.5	7	5	4	30	42	2.5
17	8	14	8.5	10	5	4	31	15	2.5
18	9	12	9	10	5	4	30	26	3
18	7	11	9	10	5	4	31	46	3
18	6	14	8.5	10	5	3	30	45	4
18	5	13	8	10	5	3	30	34	4
18	3	15	8.5	5	5	3	31	19	8
19	2	18	8.5	0	0	3	31	27	8
19	4	19	8.5	5	3	3	31	25	9
19	5	18	8.5	0	0	3	29.5	38	4
19	6	18	8	6	5	2	29.5	46	3.5
19	7	17	8.5	7	5	4	30	45	3.5
19	8	17	9	5	6	4	30	29	3.5
20	9	13	9	5	5	4	31	25	2.5
20	7	13	8.5	7	6	4	29	45	3.5
20	6	13	8	5	5	1	29	44	4
20	5	13	8.5	5	5	3	30	37	6
20	3	17	9	0	0	3	31	20	9

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Date	Station	Air Temp. (C)	Water Temp. (C)	Wind Velocity (knots)	Wind Dir.	Tide Stage	Salinity (ppt)	Water Depth (f)	Secchi (m)
July 21	2	11	9	15	6	3	30	22	5
21	4	12	8.5	25	5	3	29.5	24.5	5
21	5	14	8	30	4	3	30	38	3
22	7	12	8	20	5	4	30	44	2
22	6	12	8.5	15	5	4	29	47	3
22	5	12	8.5	10	5	4	30	38	5
22	3	12	8.5	5	4	1	31.5	21	10
23	2	12	8	18	5	4	31	22	7
23	4	11	8	24	5	4	32	26	6
23	5	12	8	28	5	3	30	38	4
24	9	12	8.5	0	0	3	29	19	2
24	7	13	8.5	0	0	3	30	44	3.5
24	6	13	8.5	0	0	3	29	45	3.5
24	5	13	8	6	5	4	30	45	4
24	3	14	8.5	5	5	4	31	20	9
25	2	20	8	10	5	4	30	22	7
25	4	17	8.5	5	5	4	31	28	8
25	5	19	8	5	5	4	30	38	6
25	6	17	8.5	0	0	1	29	44	4
25	7	16	8	7	5	3	31	42	4
25	8	13	8	7	5	3	31	24	4
26	9	14	8.5	18	5	3	31	21	2.5
26	7	14	8	26	4	3	31	44	2
27	2	15	8	18	1	4	31	22	5
27	4	18	8.5	21	8	4	31	24	6
27	5	15	8	22	8	4	32	37	5
27	6	15	8.5	25	8	4	30	47	6
27	7	15	8.5	23	8	4	30	47	3
27	8	14	8	18	8	1	29	33	2
28	9	16	8.5	6	2	3	31	19	2
28	7	18	8	0	0	3	30	44	3
28	6	17	8	5	1	3	29	44	6
28	5	16	8.5	10	2	3	31	34	9
28	3	15	8	12	2	4	32	20	8
29	2	18	8.5	0	0	3	29	26	5
29	4	15	9	9	1	2	31	23	7
29	5	16	9	0	0	4	30	40	6
29	6	17	9	0	0	4	29	46	5
29	7	15	8.5	0	0	4	31	45	3
29	8	17	8.5	0	0	4	30	27	3
30	9	12	8.5	18	6	4	29	23	2.5
30	7	12	8.5	18	6	1	31	43	3
30	6	12	9	20	6	3	29	47	3
30	5	12	9	20	6	3	31	33	5
30	3	13	8.5	15	6	3	31	23	5

[a] Wind direction code 1=north,2=northeast,3=east,4=southeast 5=south,6=southwest,7=west, and 8=northwest.

[b] Tide stage code 1=high,2=low,3=ebb, and 4=flood

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