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STATE OF ALASKA
Bill Sheffield, Governor

1984 BRISTOL BAY PACIFIC SALMON TEST FISHING PROJECTS

Edited by:
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August 1985

ALASKA DEPARTMENT OF FISH AND GAME
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Don W. Collinsworth
Commissioner

ADF&G TECHNICAL DATA REPORTS

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1984 BRISTOL BAY PACIFIC SALMON TEST FISHING PROJECTS

A summary of projects used to estimate Pacific salmon *(Oncorhynchus* sp.*)* abundance during the Bristol Bay commercial fishing season, including Port Moller offshore test fishing; Nushagak and Egegik fishing district test fishing; Kvichak, Egegik, Ugashik, and Igushik spawning escapement test fishing; and Nushagak subsistence catch monitoring and escapement estimation.

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ABSTRACT

Gillnet test fishing was conducted within Bristol Bay offshore waters during 12 June to 5 July 1984, to estimate sockeye *(Oncorhynchus nerka)* and chum *(O. keta)* salmon run timing and total abundance several days before these species actually reached commercial fishing districts. Gillnet test fishing was conducted within Nushagak and Egegik Districts during 29 June to 8 July 1984, to determine movement patterns and index sockeye salmon abundance for stocks returning to systems within these Districts. Gillnet test fishing was conducted within the Kvichak, Egegik, Ugashik, and Igushik Rivers during 18 June to 17 July 1984, to estimate sockeye salmon spawning escapement from the commercial fishery several days before actual counts were available from tower sites further upriver in clear water. Subsistence catches were monitored within the Nushagak River at Lewis Point to estimate chinook salmon *(O. tshawytscha)* spawning escapement from the commercial fishery several days before counts were available from sonar sites located further upriver at Portage Creek. Such information is used by managers in determining when to open and close commercial fishing periods so that spawning escapement goals can be met and surplus salmon can be harvested. Various methods of obtaining abundance estimates from test fishing catch data were examined and evaluated to determine which ones produced the most accurate results.

KEY WORDS: sockeye salmon, *Oncorhynchus nerka*, chum salmon, *Oncorhynchus keta*, chinook salmon, *Oncorhynchus tshawytscha*, Bristol Bay, test fishing, migratory patterns, run abundance estimation.

FOREWORD

The common goal of Bristol Bay Pacific salmon *(Oncorhynchus* sp.*)* test fishing projects is to provide fishery managers with estimates of salmon entering (total run) and leaving (escapement) commercial fishing areas before actual catch or escapement statistics became available. Every major river and lake system within Bristol Bay is managed to achieve a specific salmon spawning escapement goal (i.e., the optimum number and distribution of salmon which results in highest salmon production), while maximizing the commercial harvest of salmon in excess of these goals.

The Port Moller offshore test fishing project was developed to provide estimates of total salmon abundance several days before salmon reach commercial fishing districts, located in turbid estuaries. District test fishing projects were developed to assess salmon abundance, distribution,and movement patterns within fishing districts during fishery closures. Escapement test fishing projects (i.e., within the Kvichak, Egegik, Ugashik, Igushik, and Nushagak Rivers) were developed to provide estimates of salmon escaping the fisheries to spawn in systems where visual or sonar counts cannot be made until several days after salmon pass through fishing districts. Visual counts are made from counting towers placed on river banks in clear water areas of rivers and from aircraft. Sonar counts are made from side scanning units placed on both sides of the rivers in areas where salmon will not mill up and downriver past the site. In general, the basis for calculating estimates of salmon abundance from test fishing projects is catch per unit of effort expressed as:

$$\text{Index Points} = 6{,}000\ [C/(F)(T)],$$

where C = number of salmon caught, F = fathoms of gillnet fished, T = minutes of fishing time, and 6,000 = a constant (60 minutes x 100 fathoms) used to convert the index into catch per 100 fathom hours. Test fishing indices are converted to estimates of actual salmon abundance using historical data on total inshore return or escapement per index point. Return or escapement per index point can often be estimated more accurately when factors such as mean salmon size (length or weight) and lag time (the number of days required by salmon to travel from a specific test fishing site to the area in which abundance estimates are required) are taken into account. More detailed discussions of analytical methods are included within the individual papers presented in this report, the sixth in a series of Technical Data Reports concerning Bristol Bay test fishing projects.

1984 PORT MOLLER OFFSHORE TEST FISHING

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INTRODUCTION

Sockeye salmon *(Oncorhynchus nerka)* returning to Bristol Bay spawning grounds from Pacific Ocean feeding areas migrate northward through Alaska Peninsula and Aleutian Island passes and then northeastward through an area extending about 74 to 111 km off the coast of the Alaska Peninsula (French and Bakkala 1974). Since 1967 maturing sockeye salmon have been sampled by the Alaska Department of Fish and Game (ADF&G) along a transect perpendicular to the main migration route in the vicinity of Port Moller (Randall 1977, Meacham 1979, Huttunen 1980 and 1982, Eggers 1984, Fried in press) (Figure 1). Offshore test fishing at Port Moler was designed: 1) to estimate cumulative daily abundance of sockeye and chum *(O. keta)* salmon entering Bristol Bay, 2) to forecast sockeye salmon total run size, and 3) to obtain sockeye salmon age composition data.

METHODS

Test fishing was conducted at 11 stations, spaced at about 8 km (5 mi) intervals, along a transect extending from Port Moller towards Cape Newenham (Figure 1, Appendix Table 1). Station one was about 45 km (28 mi) offshore of Port Moller, on the 36.4 m (20 fm) contour, while station 11 was about 130 km (78 mi) offshore. Typically, odd-numbered stations were fished the same day on an outgoing trip, and even-numbered stations were fished the next day on an incoming trip. Stations were located using Loran C coordinates.

Fishing was done with a gill net 363.6 m (200 fm) long, 60 meshes deep, with 13.7 cm (5-3/8 in) stretched mesh and made from twist cable lay nylon dyed green. The boat chartered for test fishing during 1984 was the 22 m (73 ft) F/V GULF MAIDEN. A hydraulic reel was used to set and retrieve the net, which was set parallel to the transect (i.e., perpendicular to the migration route of salmon into Bristol Bay). Fishing time was approximately one hour for each station. Because the net was picked as it was retrieved, stations with large catches, requiring more time to pick the net, had longer fishing times.

Catches were standardized as sockeye or chum salmon caught per 181.8 m (100 fm) of net fished per hour, hereafter referred to as index points. Index points from stations not fished due to inclement weather or mechanical breakdowns were estimated by linear interpolation.

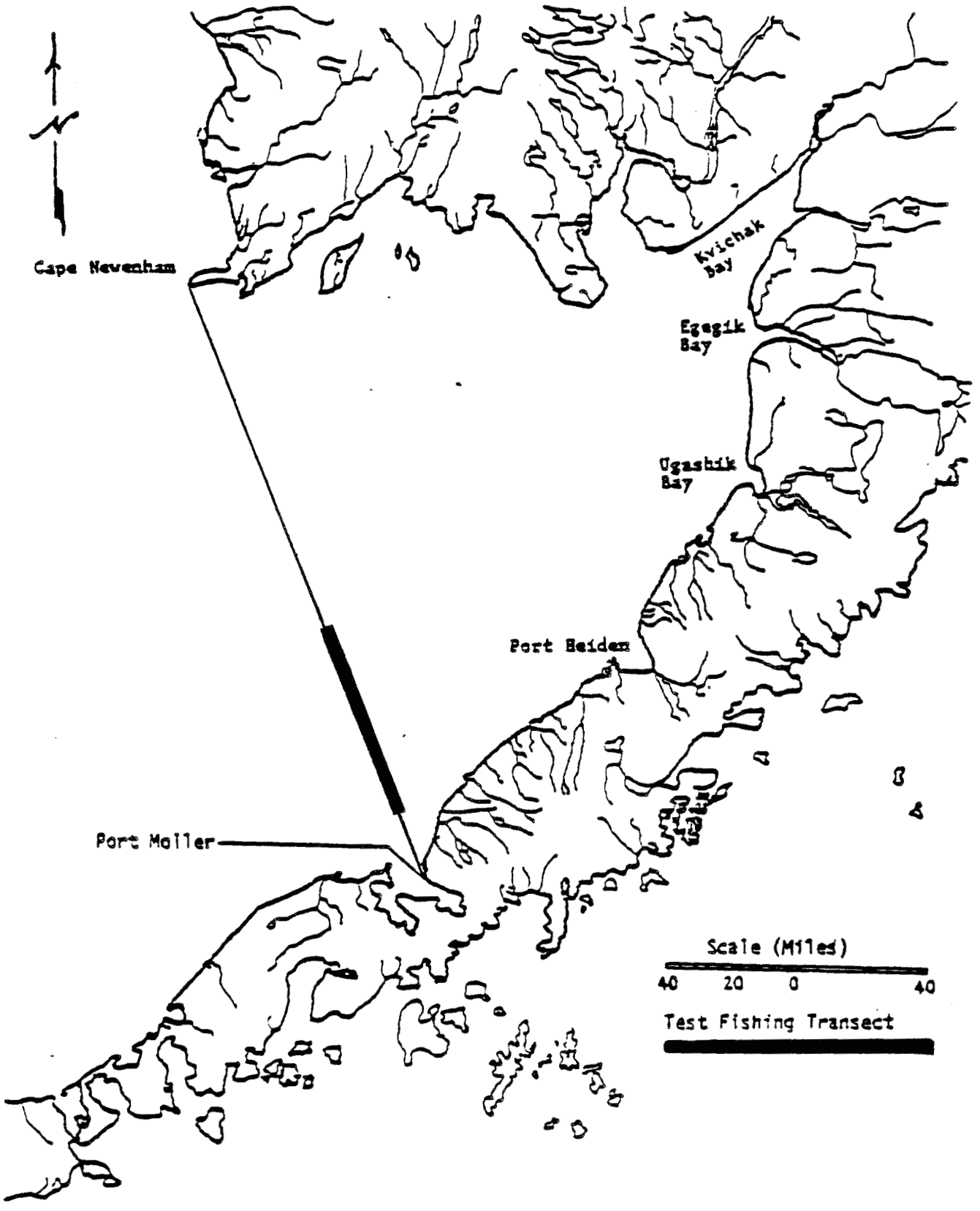


Figure 1. Transect fished during the Port Moller sockeye and chum salmon offshore gill net test fishery, 1984.

All sockeye salmon caught were measured for length (mid-eye to fork of tail, mm) and weight (kg), identified according to sex, and aged using scale samples (Appendix Table 1). Mean lengths and weights from each station were weighted by station index points to calculate daily means. Climatological data, including water surface temperatures (Appendix Table 2), wind speed and direction (Appendix Table 3), tide stage, and cloud cover were recorded during each set.

Sockeye Salmon Cumulative Daily Abundance

Three different methods were used to predict sockeye salmon passage across the Port Moller transect during the field season. All methods required an initial estimate of inshore returns per test fish point (RPI). Cumulative daily abundance was calculated by multiplying cumulative index points by estimated RPI.

The first method was based upon the historic relationship between the mean length (L) of sockeye salmon caught during test fishing and RPI (Appendix Table 3):

$$1.1.\quad RPI = 5.4171 \times 10^{54}\, L^{-19.48}.$$

The second and third methods were based upon estimating the number of days it took sockeye salmon to travel from the Port Moller test fishing site to Bristol Bay inshore waters, hereafter referred to as lag time. For the second method, a range of RPI values were calculated by dividing the most recently observed cumulative daily abundance (i.e., catch plus spawning escapement) by earlier cumulative test fish index points obtained.

$$2.1.\quad RPI = \frac{\sum_{i=1}^{t} R_i}{\sum_{i=1}^{t-d} C_i},$$

where: R = inshore return or daily abundance
C = Port Moller index points
t = most recent inshore return data
d = lag time

For the third method, RPI values were calculated by a least squares formula modified from Mundy and Mathisen (1981):

$$3.1.\quad RPI = \frac{\sum_{i=1}^{t} R_i C_{i-d}}{\sum_{i=1}^{t-d} C_i^2},$$

In both methods different lag times produced different RPI values. The lag time and corresponding RPI value that produced the smallest difference between observed and forecasted cumulative daily abundance was used to forecast the cumulative inshore run for day t+d. Lag times and RPI values that were not within the past range of values were rejected. For the least squares method, lag times and RPI values that incorrectly estimated the most recent inshore run size value were also rejected.

Sockeye Salmon Total Run Size Estimate

Three methods were used for predicting sockeye salmon total run size during the season. The first method was based upon the historic relationship between total run size (N) and mean length (L) (Appendix Table 4):

$$4.1.\quad N = 415.4 - 0.702\ L.$$

The second method was based upon the relationship between N and mean weight (W) (Appendix Table 4):

$$5.1.\quad N = 7.8641 \times 10^6\ W^{-7.28}.$$

The third method was based upon the historic relationship among the mean length (L_I) of sockeye salmon from the inshore run (catch plus escapement), marine climate during ocean residence and total run size (Appendix Table 4) (Huttunen 1979):

$$6.1.\quad \ln[N] = 18.7888 - 10.7912\ \ln[L_I] \times 11.5179\ \ln[T],$$

where: T = the sum of mean June Cold Bay air temperatures from 2 years immediately proceeding the return.

Since L has usually been greater than L_I, the following equation was used to estimate the latter (Eggers 1984):

$$7.1.\quad L_I = -85.082 + 1.135\ L.$$

Chum Salmon Daily Cumulative Daily Abundance

Chum salmon passage across the Port Moller transect was estimated using the historic mean RPI value of 13,727 chum salmon per index point.

RESULTS

Sockeye Salmon Cumulative Daily Abundance

A total of 1,085 sockeye salmon were caught during Port Moller test fishing. These catches generated a total of 613.91 index points, including interpolated values for missed fishing time (Table 1, Appendix Table 5). Overall mean length and weight of sockeye salmon captured were 547 mm (21.5 in) and 2.6 kg (5.8 lb), respectively.

Until 24 June, estimates of sockeye salmon daily passage were made using the relationship between mean length and RPI (equation 1.1). Running mean length varied within an 8 mm range during the first four days of sampling (545 mm to 552 mm) and within a 3 mm range during the remainder of the season (547 mm to 549 mm) (Table 1). RPI values calculated from the observed range of running mean length (552 mm to 545 mm) ranged from 22,740 to 24,483. Predictions of cumulative sockeye salmon abundance based upon running mean length made during the season as well as after the season were all less than actual abundance. Post-season predictions of sockeye salmon abundance based on the final running mean length for the season, 547 mm, predicted cumulative abundance to be about 14.9 million on the last day of test fishing, 5 July (Table 1). However, actual total inshore return on this date, based on catch and escapement estimates, had already exceeded this prediction and was estimated to be about 18.7 million (Appendix Table 6).

Beginning 24 June, all cumulative daily abundance estimates were based on lag time methods. Lag times ranging between 8 to 10 days and between 5 and 11 days were used in equations 2.1 and 3.1, respectively. These lag times, although generally greater than the historical mean lag time of about 7 days, greatly underestimated actual cumulative daily abundance (Table 2, Appendix Table 6). At the end of the season, 5 July, estimates based on lag time of 9 (equation 2.1) and 11 (equation 3.1) days were 20% and 30% lower, respectively, than actual inshore returns.

The beginning of the sockeye salmon run past the Port Moller transect was defined as the latest date on which cumulative index points remained less than 1% of total number of index points obtained for the season. The end of the run was defined as the date on which cumulative index points exceeded 99% of the total obtained for the season. Given these definitions the duration of the run past Port Moller was 22 days; it began on 12 June and ended on 3 July. About half of the total number of index points were obtained by 24 June (Figures 2 and 3). Because 26 or 27 June have been the most common dates when 50% of the run had passed Port Moller, timing of the 1984 run was considered to have been early.

Using similar definitions for the beginning and ending of the sockeye salmon run (catch plus escapement) into Bristol Bay inshore waters, the duration of the inshore run was 28 days; it began on 21 June (total cumulative return of about 400,000 sockeye salmon) and ended on 18 July (total cumulative return of over 41 million sockeye salmon). About half of the total inshore run was accounted for by 6 July (Figures 2 and 3). Because 4 or 5 July have been the

Table 1. Daily summary of sockeye salmon catch, index, mean size, and estimated passage across the Port Moller offshore test fishing transect, Bristol Bay, 1984. Passage estimates based upon return per index point of 24,320, calculated from a running mean length 547 mm (equation 1.1 in text).

				RUNNING MEAN		ESTIMATED PASSAGE		
DATE	SETS	CATCH	INDEX	WEIGHT(KG)	LENGTH(MM)	DAILY	CUMULATIVE	
6/12	6	9	4.32	2.67	548	105,056	105,056	
6/13	5	25	14.21	2.50	545	345,581	450,637	
6/14	6	9	4.71	2.68	546	114,580	565,218	
6/15	5	18	9.36	2.68	552	227,524	792,742	
6/16	6	36	18.10	2.61	547	440,269	1,233,012	
6/17	5	119	55.22	2.65	546	1,343,038	2,576,050	
6/18	6	67	31.44	2.67	547	764,538	3,340,589	
6/19	5	58	27.40	2.92	548	666,276	4,006,866	
6/20	2	50	34.04	2.67	548	827,780	4,834,646	*
6/21	5	30	15.98	2.67	548	388,693	5,223,340	
6/22	3	34	23.23	2.66	549	564,875	5,788,215	*
6/23	0	28	28.90	2.66	549	702,853	6,491,068	*
6/24	6	78	37.33	2.66	548	907,929	7,398,998	
6/25	5	53	28.14	2.64	548	684,371	8,083,369	*
6/26	6	235	117.62	2.63	547	2,860,618	10,943,987	
6/27	5	29	15.95	2.63	547	387,910	11,331,898	
6/28	6	119	65.53	2.64	547	1,593,814	12,925,713	
6/29	5	21	11.37	2.63	547	276,514	13,202,227	
6/30	3	8	5.89	2.64	547	143,226	13,345,454	*
7/ 1	5	47	25.90	2.64	547	629,996	13,975,450	
7/ 2	6	52	28.89	2.64	547	702,654	14,678,104	
7/ 3	5	8	4.33	2.64	547	105,261	14,783,365	
7/ 4	2	5	5.00	2.64	547	121,623	14,904,988	*
7/ 5	5	2	1.05	2.64	547	25,512	14,930,500	

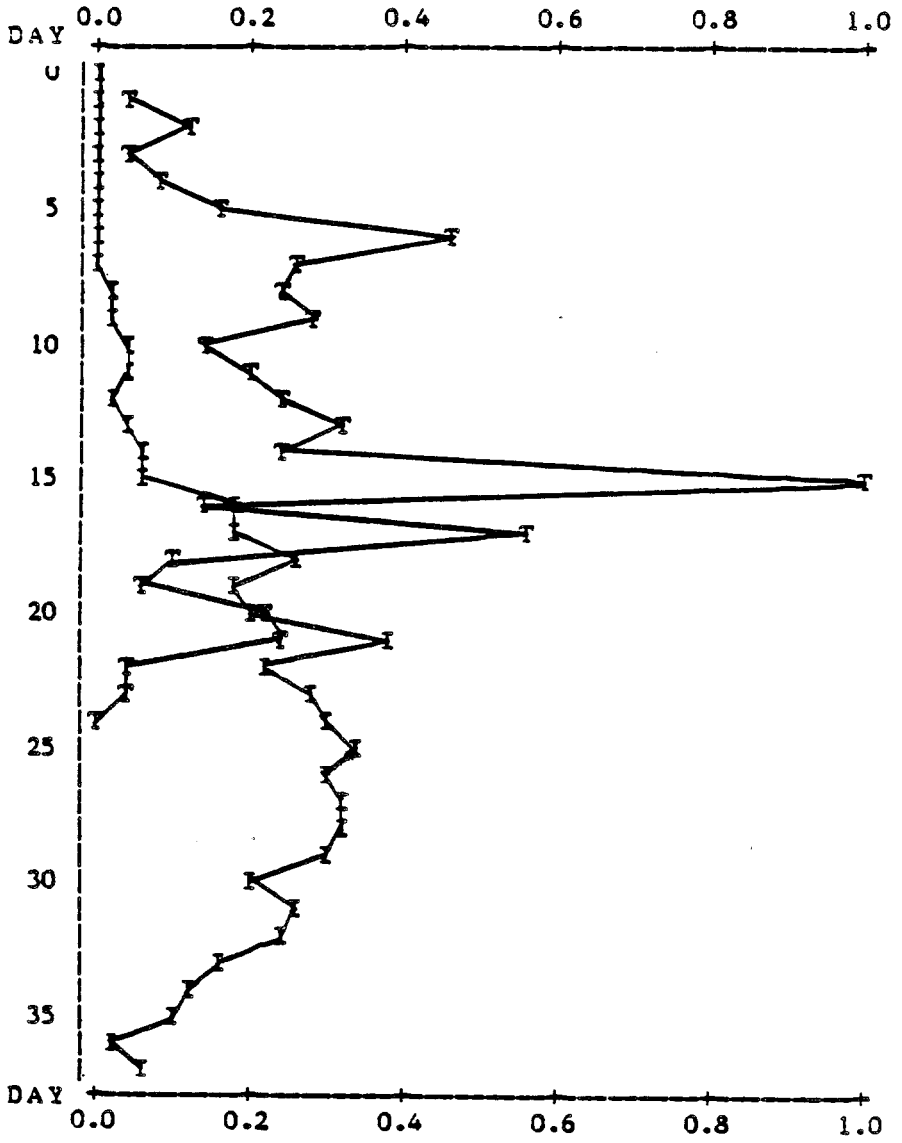
* Includes interpolated values for missed stations.

Table 2. Daily estimates of sockeye salmon cumulative passage across the Port Moller transect, Bristol Bay, 1984, based upon lag time analysis. Estimates made during the season were compared with those made after the season to examine the performance of this analysis method.

	Sockeye salmon cumulative abundance estimates								
	Within-Season (Equation 2.1)		Post-Season			Within-Season (Equation 3.1)		Post-Season		
Date	Lag (days)	Passage (numbers)	Date plus lag	Passage (numbers)	Percent Error[1]	Lag (days)	Passage (numbers)	Date plus lag	Passage (numbers)	Percent Error[1]
* 6/20	8	5,294,422	6/28	4,869,784	9	6	1,745,827	6/26	2,244,574	-22
6/21	8	3,430,780	6/29	6,862,853	-50	6	3,080,883	6/27	3,562,654	-14
* 6/22	8	4,446,326	6/30	8,305,885	-46	6	3,586,726	6/28	4,869,784	-26
**6/23	-- no forecast made --					-- no forecast made --				
6/24	8	5,284,210	7/ 2	12,727,228	-58	5	2,031,363	6/29	6,862,853	-70
6/25	9	12,653,758	7/ 4	16,480,806	-23	5	2,625,189	6/30	8,305,885	-68
6/26	10	19,646,916	7/ 6	21,311,106	- 8	5	3,918,610	7/ 1	9,794,921	-60
6/27	10	13,693,264	7/ 7	23,669,694	-42	5	5,689,409	7/ 2	12,727,228	-55
6/28	10	17,018,180	7/ 8	26,145,144	-35	8	10,785,056	7/ 6	21,311,694	-49
6/29	10	21,810,124	7/ 9	28,538,538	-24	8	13,126,178	7/ 7	23,669,694	-45
* 6/30	9	23,501,688	7/ 9	28,538,538	-18	10	19,550,890	7/10	30,870,476	-37
7/ 1	9	23,636,694	7/10	30,870,476	-23	10	21,704,930	7/11	32,424,114	-33
7/ 2	9	28,586,072	7/11	32,424,114	-12	8	22,057,570	7/10	30,870,476	-29
7/ 3	8	26,549,008	7/11	32,424,114	-18	9	24,703,366	7/12	34,461,234	-28
* 7/ 4	9	32,127,768	7/13	36,331,040	-12	10	28,879,322	7/14	37,556,440	-16
7/ 5	9	26,168,220	7/14	37,556,440	-30	11	31,209,504	7/16	39,219,870	-20

* Within-season estimate includes interpolated values for missed stations.

** No forecast on 6/23 due to test fishing boat not fishing that day.



INDEX	INSHORE
0.00	163.00
4.32	738.00
14.21	1520.00
4.71	3167.00
9.36	5320.00
18.10	1894.00
55.22	0.00
31.44	49038.00
27.40	93176.00
34.04	126553.00
15.98	278549.00
23.23	286054.00
28.90	147448.00
37.33	312866.00
28.14	464264.00
117.62	473824.00
15.95	1318080.00
65.53	1307130.00
11.37	1993069.00
5.89	1443032.00
25.90	1489036.00
28.89	2932307.00
4.33	1617144.00
5.00	2136434.00
1.05	2215458.00
	2614842.00
	2358587.00
	2475449.00
	2393394.00
	2331938.00
	1553637.00
	2037122.00
	1869801.00
	1235399.00
	955482.00
	697949.00
	149604.00
	404808.00

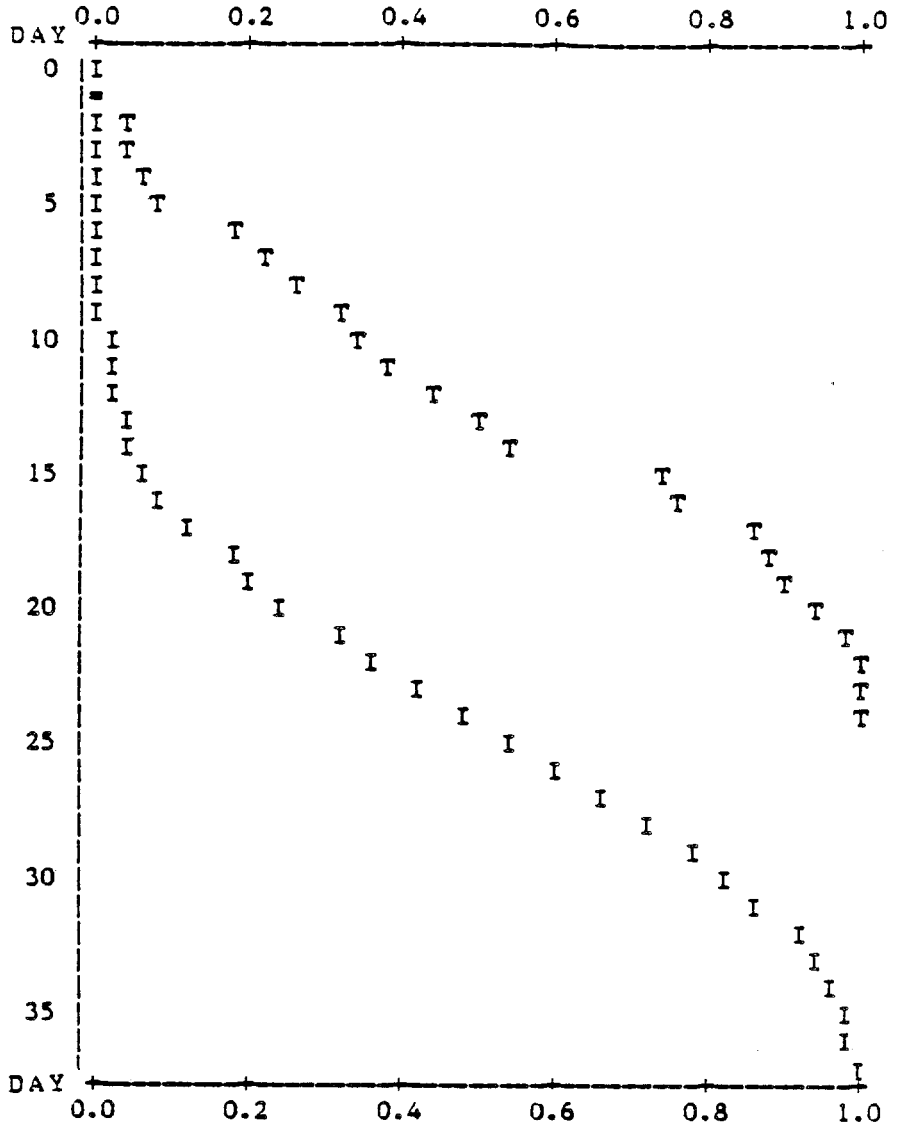
INDEX INSHORE

TIME LAG = 0

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	37
INSHORE	I	45

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 2. Daily test fish indices (T) and inshore run (I) between 11 June (Day = 0) and 17 July (Day = 37).



INDEX	INSHORE
0.00	163.00
4.32	901.00
18.53	2421.00
23.24	5588.00
32.60	10908.00
50.70	12802.00
105.92	12802.00
137.36	61840.00
164.75	155016.00
198.79	281569.00
214.77	560118.00
238.00	846172.00
266.90	993620.00
304.23	1306486.00
332.37	1770750.00
450.00	2244574.00
465.95	3562654.00
531.48	4869784.00
542.85	6862853.00
548.74	8305885.00
574.64	9794921.00
603.54	12727228.00
607.86	14344372.00
612.86	16480806.00
613.91	18696264.00
	21311106.00
	23669694.00
	26145144.00
	28538538.00
	30870476.00
	32424114.00
	34461236.00
	36331036.00
	37566436.00
	38521920.00
	39219868.00
	39369472.00
	39774280.00

INDEX INSHORE

TIME LAG = 0

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	37
INSHORE	I	45

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 3. Cumulative test fish indices (T) and inshore run (I) between 11 June (Day = 0) and 17 July (Day = 37).

most common dates when 50% of the inshore run has been obtained, timing of the 1984 inshore run was considered to have been late. Lag time between the 50% date for Port Moller index points (24 June) and the 50% date for the Bristol Bay inshore run (6 July) was 12 days; longer than lag time estimates used during the season.

Sockeye Salmon Total Run Size

All three methods used (equations 4.1, 5.1, and 6.1) underestimated total sockeye salmon run size throughout the season (Table 3). Estimates closest to actual total run size were based upon the relationship between mean length and total run size (equation 4.1).

The actual 1984 Bristol Bay inshore run was comprised of a greater number of two-ocean sockeye salmon than was expected from pre-season forecast estimates (Table 4) (Eggers et al. 1983). However, age composition of Port Moller samples, even when adjusted for lower catchability of two-ocean sockeye salmon, was more similar to that of the pre-season forecast than the actual inshore run (Table 4 and Appendix Table 7). This information did not suggest that pre-season forecast expectations were inaccurate.

Chum Salmon Cumulative Daily Abundance

A total of 198 chum salmon were caught during Port Moller test fishing. These catches generated a total of 111.75 index points, including interpolated values for missed fishing time (Appendix Table 8).

A total of about 1.5 million chum salmon were estimated to have passed the Port Moller transect during the season (Table 5). Actual total run size was 1.8 million, about 20% greater than Port Moller test fishing catches predicted.

Table 3. Daily forecasts of total sockeye salmon returns to Bristol Bay in 1984 based upon mean size of sockeye salmon in Port Moller test fishing catches. Actual total inshore return was estimated to be about 41.0 million sockeye salmon.

Date	Total Run Size Estimates (millions of sockeye)		
	Length Model (Equation 4.1)	Weight Model (Equation 5.1)	Length-Temperature Model (Equation 6.1)
6/12	37	19	23
6/13	34	36	21
6/14	31	27	24
6/15	27	19	22
6/16	31	22	25
6/17	31	20	25
6/18	31	19	25
6/19	30	18	24
6/20	30	19	24
6/21	30	19	24
6/22	29	20	24
6/23	29	20	24
6/24	30	20	24
6/25	30	20	24
6/26	30	21	24
6/27	31	21	25
6/28	30	21	24
6/29	31	21	25
6/30	31	21	25
7/01	31	21	25
7/02	30	21	25
7/03	30	21	25
7/04	30	21	25
7/05	30	21	24

Table 4. Comparisons of age class composition estimates of the total Bristol Bay sockeye salmon run made before, during, and after the 1984 season.

Age Class	Age Class Composition (%)			
	Pre-season Forecast[1]	Port Moller Catch	Within Season Forecast[2]	Inshore Total Run
4 2	27.0	9.3	-	15.1
5 3	33.5	40.5	-	54.5
Total two-ocean	60.0	49.8	56.2	69.6
5 2	30.0	27.4	-	19.6
6 3	10.0	21.3	-	10.3
Total three-ocean	40.0	48.7	43.8	29.9
Others	0.0	1.5	-	0.5

[1] Based upon published pre-season forecast (Eggers et al. 1983).

[2] Based upon adjusted proportion of two-ocean sockeye salmon in Port Moller catch (Eggers 1984):

$$Y = 5.539 + 1.018X, \text{ where}$$

Y = proportion of two-ocean sockeye salmon in inshore return, and

X = proportion of two-ocean sockeye salmon in Port Moller catch.

Table 5. Daily summary of chum salmon catch, index, and estimated passage across the Port Moller offshore test fishing transect, Bristol Bay, 1984. Passage estimates based upon historic mean return per index of 13,727.

Date	Number of stations fished	Chum Catch (numbers)	Index	Estimated Passage	
				Daily	Cumulative
6/12	6	10	4.69	64,380	64,380
6/13	5	2	1.07	14,688	78,768
6/14	6	12	6.34	87,029	165,797
6/15	5	15	7.72	105,972	271,769
6/16	6	14	7.06	96,913	368,682
6/17	5	10	4.70	64,517	433,199
6/18	6	13	6.02	82,637	515,836
6/19	5	14	7.48	102,678	618,514
* 6/20	2	5	3.18	43,652	662,166
6/21	5	5	2.67	36,651	698,817
* 6/22	3	3	2.11	28,964	727,781
* 6/23	0	5	5.10	70,008	797,789
6/24	6	9	4.52	62,046	859,835
6/25	5	14	7.35	100,893	960,728
6/26	6	27	13.67	187,648	1,148,376
6/27	5	5	2.73	37,475	1,185,851
6/28	6	13	7.32	100,482	1,286,333
6/29	5	7	3.64	49,966	1,336,299
* 6/30	3	2	2.30	31,572	1,367,871
7/ 1	5	12	6.62	90,873	1,458,744
7/ 2	6	4	2.24	30,748	1,489,492
7/ 3	5	1	0.54	7,413	1,496,905
* 7/ 4	2	2	1.09	14,962	1,511,867
7/ 5	5	3	1.59	21,826	1,533,693

* Includes interpolated values for missed stations.

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APPENDIX

Appendix Table 1. Port Moller, Bristol Bay, offshore test fishing data, 1984, for sockeye and chum salmon.

					Sockeye Salmon								
							Mean		Chum Salmon			Angle	
Date	Set No.	Sta.	Gill net length (fathoms)	Mean fishing time (MIN)	catch	index	Wt. (kg)	Ln. (mm)	catch	index	Tide Stage	Set	Haul
6/12	1	1	200	66.0	3	1.37	3.08	563	0		4	225	225
6/12	2	3	200	64.0	0				0		3	225	225
6/12	3	5	200	55.5	2	1.08	2.15	508	0		3	225	225
6/12	4	7	200	64.0	4	1.88	2.68	561	10	4.70	2	180	360
6/12	5	9	200	62.5	0				0		4	180	180
6/12	6	11	200	56.5	0				0		4	180	180
6/13	7	10	200	62.0	2	0.97	2.26	545	0		2	135	180
6/13	8	8	200	58.0	0				0		4	135	135
6/13	9	6	200	51.5	12	7.00	2.51	557	1	0.58	1	135	135
6/13	10	4	200	50.0	8	4.80	2.21	518	0		3	135	135
6/13	11	2	200	62.0	3	1.45	3.09	573	1	0.48	3	135	135
6/14	12	1	200	53.0	2	1.13	3.04	532	0		2	135	135
6/14	13	3	200	60.0	4	2.00	2.38	540	0		4	135	135
6/14	14	5	200	57.5	0				0		1	135	135
6/14	15	7	200	56.0	1	.54	3.20	594	6	3.22	3	135	135
6/14	16	9	200	57.0	1	.53	3.60	626	3	1.58	3	135	135
6/14	17	11	200	58.0	1	.52	2.22	506	3	1.55	2	135	135
6/15	18	10	200	59.0	4	2.03	3.17	582	7	3.56	2	90	90
6/15	19	8	200	56.0	4	2.14	3.18	569	4	2.14	4	135	135
6/15	20	6	200	51.5	3	2.33	2.80	574	0		4	135	135
6/15	21	4	200	61.5	6	2.93	2.75	548	0		3	135	135
6/15	22	2	200	59.5	1	.50	3.65	605	4	2.02	2	135	135
6/16	23	1	200	57.5	0				1	0.52	3	135	135
6/16	24	3	200	61.0	16	7.87	2.51	536	1	0.49	3	135	135
6/16	25	5	200	59.0	8	4.06	2.39	535	1	0.51	4	315	315
6/16	26	7	200	57.5	3	1.57	2.58	531	2	1.04	1	315	315
6/16	27	9	200	61.5	5	2.44	2.56	545	7	3.42	3	135	135
6/16	28	11	200	55.5	4	2.16	2.62	539	2	1.08	3	135	315
6/17	29	10	200	65.0	20	9.24	3.03	572	8	3.67	3	315	315
6/17	30	8	200	66.5	14	6.32	2.83	549	0		2	315	315
6/17	31	6	200	67.0	70	31.36	2.60	540	1	0.45	4	135	225
6/17	32	4	200	54.0	15	8.34	2.51	540	0		1	135	180
6/17	33	2	200	54.0	0				1	0.56	3	135	225

-Continued-

Appendix Table 1. Port Moller, Bristol Bay, offshore test fishing data, 1984, for sockeye and chum salmon (continued).

Date	Set No.	Sta.	Gill net length (fathoms)	Mean fishing time (MIN)	Sockeye Salmon catch	Sockeye Salmon index	Sockeye Salmon Mean Wt. (kg)	Sockeye Salmon Mean In. (mm)	Chum Salmon catch	Chum Salmon index	Tide Stage	Angle Set	Angle Haul
6/18	34	1	200	55.5	0				0		3	315	270
6/18	35	3	200	54.5	1	.55	3.00	562	0		3	315	270
6/18	36	5	200	62.5	25	12.00	2.63	546	2	0.96	2	315	270
6/18	37	7	200	67.0	35	15.70	2.88	553	10	4.48	4	315	225
6/18	38	9	200	51.5	0				1	0.58	1	315	270
6/18	39	11	200	56.0	6	3.22	2.61	541	0		3	315	315
6/19	40	10	200	68.5	42	18.39	2.83	568	4	1.75	3	135	270
6/19	41	8	200	52.0	4	2.31	2.36	532	6	3.46	3	135	180
6/19	42	6	200	54.5	7	3.85	2.41	526	0		4	135	180
6/19	43	4	200	52.5	2	1.14	3.35	577	1	0.57	4	135	180
6/19	44	2	200	53.0	3	1.70	2.98	536	3	1.70	4	135	180
6/20	45	5	200	56.5	16	8.50	2.57	542	3	1.60	3	135	135
6/20	46	7	200	51.0	22	12.90	2.55	548	1	0.59	3	135	135
6/20		1[1]	100	60.0	1	1.36			0				
8/20		3[1]	100	60.0	6	6.12			0				
6/20		9[1]	100	60.0	1	1.70			1	1.07			
6/20		11[1]	100	60.0	3	3.40			0				
6/21	47	10	200	58.5	6	3.08	2.57	545	1	0.51	3	135	135
6/21	48	8	200	55.5	4	2.16	3.19	579	2	1.08	3	135	135
6/21	49	6	200	56.0	10	5.36	2.22	539	1	0.54	3	135	135
6/21	50	4	200	56.0	4	2.14	2.63	552	1	0.54	4	135	135
6/21	51	2	200	55.5	6	3.25	2.86	567	0		4	135	135
6/22	52	1	200	51.5	1	0.58	2.92	576	0		3	315	315
6/22	53	3	200	50.0	5	3.00	2.43	532	1	0.60	3	315	315
6/22	54	5	200	59.0	17	8.64	2.55	561	1	0.51	3	45	135
6/22		7[1]	100	60.0	9	9.00			0				
6/22		9[1]	100	60.0	1	1.00			1	1.18			
6/22		11[1]	100	60.0	1	3.00			0				
6/23		2[1]	100	60.0	4	4.32			1	1.40			
6/23		4[1]	100	60.0	4	4.62			0	0.60			
6/23		6[1]	100	60.0	7	7.81			0	0.40			
6/23		8[1]	100	60.0	4	4.14			1	1.10			
6/23		10[1]	100	60.0	8	8.10			1	1.60			

-Continued-

Appendix Table 1. Port Moller, Bristol Bay, offshore test fishing data, 1984, for sockeye and chum salmon (continued).

					Sockeye Salmon								
							Mean		Chum Salmon			Angle	
Date	Set No.	Sta.	Gill net length (fathoms)	Mean fishing time (MIN)	catch	index	Wt. (kg)	ln. (mm)	catch	index	Tide Stage	Set	Haul
6/24	55	1	200	55.5	2	1.08	3.23	575	2	1.08	3	315	315
6/24	56	3	200	57.5	10	5.22	2.63	551	3	1.57	3	315	270
6/24	57	5	200	61.5	37	18.10	2.45	544	2	2.44	3	135	180
6/24	58	7	200	67.0	29	13.00	2.90	548	2	0.90	4	315	315
6/24	59	9	200	52.5	0				0		4	225	225
6/24	60	11	200	50.0	0				0		1	225	225
6/25	61	10	200	60.0	0				0		4	225	225
6/25	62	8	200	56.5	10	5.31	2.70	550	2	1.06	3	135	135
6/25	63	6	200	54.5	3	1.65	2.57	537	1	0.55	3	225	225
6/25	64	4	200	55.5	21	11.35	2.40	546	2	1.10	3	135	180
6/25	65	2	200	58.0	19	9.82	2.65	544	9	4.65	4	135	180
6/26	67	1	200	50.5	5	5.97	3.05	578	5	2.97	4	180	180
6/26	68	3	200	60.5	62	29.80	2.37	540	4	1.92	1	135	135
6/26	69	5	200	57.0	35	18.40	2.63	543	0		3	135	180
6/26	70	7	200	53.0	25	14.20	2.48	532	0		2	135	135
6/26	71	9	200	63.5	105	49.60	2.72	552	16	7.55	4	135	135
6/26	72	11	200	52.0	3	1.73	3.00	587	2	1.15	3	135	135
6/27	73	10	200	55.0	23	12.50	2.73	541	5	2.73	4	135	135
6/27	74	8	200	50.0	0				0		4	135	135
6/27	75	6	200	50.0	1	0.60	2.42	539	0		3	270	270
6/27	76	4	200	55.5	1	0.56	1.92	498	0		3	90	90
6/27	77	2	200	53.0	4	2.26	2.31	541	0		2	45	45
6/28	78	1	200	53.5	17	9.54	2.64	536	5	2.81	4	360	360
6/28	79	3	200	51.0	3	1.76	2.45	553	1	0.59	4	360	360
6/28	80	5	200	53.0	9	5.09	2.79	560	1	0.57	1	315	315
6/28	81	7	200	56.0	32	17.20	2.66	539	2	1.07	3	315	270
6/28	82	9	200	52.5	26	14.80	2.76	557	4	2.28	1	315	270
6/28	83	11	200	56.0	32	17.20	2.70	556	0		4	360	315
6/29	84	10	200	50.0	1	0.60	2.04	501	0		3	225	225
6/29	85	8	200	50.0	0				0		4	225	225
6/29	86	6	200	52.5	5	2.86	2.45	533	2	1.14	4	135	180
6/29	87	4	200	51.5	5	2.91	2.25	531	0		3	315	225
6/29	88	2	200	60.0	10	5.50	2.57	535	5	2.50	3	45	90

-Continued-

Appendix Table 1. Port Moller, Bristol Bay, offshore test fishing data, 1984, for sockeye and chum salmon (continued).

Date	Set No.	Sta.	Gill net length (fathoms)	Mean fishing time (MIN)	Sockeye Salmon catch	Sockeye Salmon index	Sockeye Salmon Mean Wt. (kg)	Sockeye Salmon Mean Ln. (mm)	Chum Salmon catch	Chum Salmon index	Tide Stage	Angle Set	Angle Haul
6/30		1[1]	100	60.0	0	0.30			0				
6/30		3[1]	100	60.0	0	0.90			0				
6/30	89	5	200	50.5	1	0.59	3.55	576	0		3	180	180
6/30	90	7	200	52.5	0				0		3	180	180
6/30	91	9	200	51.5	6	3.50	2.59	536	0		2	180	180
6/30		11[1]	100	60.0	0	0.60			0				
7/ 1	92	10	200	56.5	18	9.56	2.56	554	5	2.66	3	135	135
7/ 1	93	8	200	53.5	17	9.53	3.06	548	3	1.68	3	135	135
7/ 1	94	6	200	51.5	0				0		4	180	180
7/ 1	95	4	200	52.5	4	2.28	2.81	549	4	2.29	4	135	180
7/ 1	96	2	200	53.0	8	4.53	2.79	549	0		4	315	180
7/ 2	97	1	200	53.0	5	2.83	2.21	529	2	1.13	3	315	45
7/ 2	98	3	200	52.5	1	0.57	2.58	551	0		3	315	360
7/ 2	99	5	200	55.5	17	9.20	2.32	541	1	0.54	4	315	45
7/ 2	100	7	200	53.5	6	3.37	3.04	552	0	0.54	4	315	45
7/ 2	101	9	200	52.5	10	5.71	2.63	560	1	0.57	3	45	45
7/ 2	102	11	200	54.0	13	7.23	2.85	557	0		3	315	45
7/ 3	103	10	200	56.0	0				0		3	45	45
7/ 3	104	8	200	56.0	2	1.07	2.41	526	1	0.54	3	45	90
7/ 3	105	6	200	58.0	0				0		4	45	90
7/ 3	106	4	200	54.0	4	2.22	2.62	561	0		4	45	90
7/ 3	107	2	200	58.0	2	1.03	2.68	552	0		1	45	90
7/ 4	108	1	200	55.5	0				1	0.54	3	45	45
7/ 4	109	3	200	54.5	2	1.10	2.94	594	1	0.54	4	45	90
7/ 4		5[1]	100	60.0	1	1.10			0				
7/ 4		7[1]	100	60.0	1	1.20			0				
7/ 4		9[1]	100	60.0	1	1.10			0				
7/ 4		11[1]	100	60.0	0	0.50			0				
7/ 5	110	2	200	59.0	1	0.51	3.10	579	1	0.51	3	45	90
7/ 5	111	4	200	55.5	1	0.54	2.92	566	2	1.08	4	90	90
7/ 5	112	6	200	60.0	0				0		4	45	90
7/ 5	113	8	200	51.0	0				0		1	45	45
7/ 5	114	10	200	50.5	0				0		3	45	90

[1] Station not fished, data interpolated.

Appendix Table 2. Surface water temperatures (C) recorded at Port Moller, Bristol Bay, test fishing stations, 1984.

	Station											
Date	1	2	3	4	5	6	7	8	9	10	11	MEAN
6/12	9.0		9.0		9.0		9.0		8.0		8.0	8.7
6/13		7.0		8.0		8.0		9.0		9.0		8.2
6/14	7.0		9.0		7.0		8.0		8.0		6.0	7.5
6/15		9.0		8.0		8.0		7.0		6.0		7.6
6/16	7.0		8.0		9.0		9.0		9.0		8.0	8.3
6/17		11.0		10.0		9.0		7.0		8.0		9.0
6/18	8.0		10.0		10.0		9.0		9.0		8.0	9.0
6/19		10.0		11.0		10.0		9.0		8.0		9.6
6/20					11.0		9.0					10.0
6/21		11.0		11.0		10.0		9.0		8.0		9.8
6/22	10.0		10.0		10.0							10.0
6/23												
6/24	8.0		8.0		10.0		10.0		9.0		10.0	9.2
6/25		8.0		9.0		8.0		10.0		10.0		9.0
6/26	9.0		9.0		9.0		9.0		10.0		10.0	9.3
6/27		8.0		9.0		9.0		9.0		9.0		8.8
6/28	8.0		9.0		10.0		10.0		10.0		10.0	9.5
6/29		9.0		9.0		9.0		10.0		9.0		9.2
6/30					9.0		9.0		10.0			9.3
7/ 1		9.0		10.0		10.0		10.0		10.0		9.8
7/ 2	10.0		10.0		10.0		11.0		11.0		11.0	10.5
7/ 3		10.0		11.0		11.0		11.0		10.0		10.6
7/ 4	10.0		10.0									10.0
7/ 5		9.0		10.0		11.0		10.0		10.0		10.0
Mean	8.6	9.2	9.2	9.6	9.5	9.4	9.3	9.2	9.3	8.8	8.9	9.2

Appendix Table 3. Wind speed (km/hr) and direction recorded at Port Moller, Bristol Bay, test fishing stations, 1984.

	Station											
Date	1	2	3	4	5	6	7	8	9	10	11	MEAN
6/12	2.7 NE		8.1 NE		6.5 NE		2.7 N		8.1 N		8.1 N	6.0
6/13		2.7 NW		8.1 NW		5.4 NW		5.4 NW		1.6 NW		4.6
6/14	6.5 NW		8.1 NW		5.4 NW		8.1 NW		9.7 NW		10.8 NW	8.1
6/15		2.7 W		1.1 W		2.7 W		5.4 NW		2.7 SW		2.9
6/16					2.7 E		2.7 E				2.7 NE	2.7
6/17				2.7 W		2.7 E		5.4 E		2.7 E		3.4
6/18					2.7 SE		2.7 E					2.7
6/19		2.7 N										2.7
6/20					5.4 NW		5.4 NW					5.4
6/21										2.7 NW		
6/22	13.5 SE		13.5 SE		13.5 SE							13.5
6/23												
6/24							5.4 NE		5.4 NE		8.1 NE	6.3
6/25		2.7 NE		8.1 NE		8.1 NE		5.4 NE		9.2 NE		6.7
6/26			8.1 N		8.1 N		8.1 N		8.1 N		8.1 N	8.1
6/27		13.5 SW		10.8 SW		13.5 W		13.5 W		10.8 N		12.4
6/28	13.5 SE		8.1 S		5.4 E		2.7 E		2.7 E		2.7 NE	5.9
6/29				5.4 E		8.1 E		5.4 E		2.7 NE		5.4
6/30					10.8 N		10.8 N		10.8 N			10.8
7/ 1		2.7 NW				2.7 NE						2.7
7/ 2			2.7 S		5.4 S		5.4 S		2.7 S			4.1
7/ 3		8.1 SW		10.8 SW		5.4 SW		8.1 SW		8.1 SW		8.1
7/ 4	10.8 SW		13.5 SW									12.2
7/ 5		10.8 SW		10.8 SW		10.8 SW		10.8 SW		8.1 SW		10.3
Mean	9.4	5.7	7.0	7.2	10.0	6.6	10.0	7.4	7.0	5.4	6.8	6.6

Appendix Table 4. Total inshore return and mean length of sockeye salmon in relation to Port Moller test fishing and Cold Bay air temperature indices, Bristol Bay, 1968-1984.

Year	Inshore Return (Million)	Port Moller Index	Inshore Return (Thousands) Per Index Point	Cold Bay[1] Air Temperature Index (F)	Port Moller[2] Mean Weight (kg)	Port Moller[2] Mean Length (mm)	Inshore Mean Length (mm)[2]
1968	8.00	305.95	26.15	91.0	2.54	545.53	534.7
1969	19.97	602.97	32.16	92.2	2.40	537.79	520.2
1970	39.39	823.38	47.84	92.3	2.22	526.11	510.5
1971	15.82	680.50	23.35	94.7	2.65	549.37	552.4
1972	5.37	97.72	54.95	88.3	2.94	553.70	543.7
1973	2.42	339.60	7.13	82.1	3.31	582.87	572.9
1974	10.94	-	-	84.1	-	-	527.6
1975	24.20	1289.30	18.77	88.3	2.38	547.13	522.7
1976	11.47	688.60	16.66	92.0	2.78	552.95	543.5
1977	9.47	782.10	12.11	90.8	3.18	565.67	557.5
1978	19.65	446.54	44.01	94.2	2.76	541.25	536.8
1979	40.80	1034.45	39.44	96.6	2.71	546.53	538.8
1980	62.28	526.78	118.23	97.6	2.68	542.71	524.6
1981	34.58	1052.15	32.27	95.9	3.00	566.49	556.0
1982	22.13	758.94	29.16	93.5	3.06	567.00	560.8
1983	45.78	645.15	70.96	92.6	2.61	527.89	528.8
1984	40.96	613.91	66.72	93.4	2.64	547.76	524.62

[1] Sum of mean June Cold Bay air temperatures for the two years prior to the inshore spawning return.

[2] Length measured from mid-eye to tail fork.

Appendix Table 5. Port Moller, Bristol Bay, sockeye salmon test fishing index points by station, 1984. Interpolated values are enclosed in brackets ([]).

	Station											
Date	1	2	3	4	5	6	7	8	9	10	11	TOTAL
6/12	1.36		0.00		1.08		1.87		0.00		0.00	4.32
6/13		1.45		4.80		6.99		0.00		0.97		14.21
6/14	1.13		2.00		0.00		0.54		0.53		0.52	4.71
6/15		0.50		2.93		1.75		2.14		2.03		9.36
6/16	0.00		7.87		4.07		1.57		2.44		2.16	18.10
6/17		0.00		8.33		31.34		6.32		9.23		55.22
6/18	0.00		0.55		12.00		15.67		0.00		3.21	31.44
6/19		1.70		1.14		3.85		2.31		18.39		27.40
6/20	[1.40]		[6.10]		8.50		12.94		[1.70]		[3.40]	34.04[1]
6/21		3.24		2.14		5.36		2.16		3.08		15.98
6/22	0.58		3.00		8.64		[9.00]		[1.00]		[1.00]	23.23[1]
6/23		[4.30]		[4.60]		[7.80]		[4.10]		[8.10]		28.90[1]
6/24	1.08		5.22		18.05		12.99		0.00		0.00	37.33
6/25		9.83		11.35		1.65		5.31		0.00		28.14
6/26	2.97		30.74		18.42		14.15		49.61		1.73	117.62
6/27		2.26		.54		0.60		0.00		12.55		15.95
6/28	9.53		1.76		5.09		17.14		14.86		17.14	65.53
6/29		5.00		2.91		2.86		0.00		0.60		11.37
6/30	[0.30]		[0.90]		0.59		0.00		3.50		[0.60]	5.89[1]
7/ 1		4.53		2.29		0.00		9.53		9.56		25.90
7/ 2	2.83		0.57		9.19		3.36		5.71		7.22	28.89
7/ 3		1.03		2.22		0.00		1.07		0.00		4.33
7/ 4	0.00		1.10		[1.10]		[1.20]		[1.10]		[0.50]	5.00[1]
7/ 5		0.51		0.54		0.00		0.00		0.00		1.05
Total	21.19	34.36	59.82	43.80	86.74	62.20	90.43	32.94	80.44	64.51	37.49	613.91
Percent	3	6	10	7	14	10	15	5	13	11	6	100

[1] Totals include interpolated values.

Appendix Table 6. Preliminary 1984 daily and cumulative Bristol Bay catch, escapement, and total inshore run (including estimated number of sockeye salmon in rivers below counting tower sites).

Date	Catch[1]		Escapement		Catch + Escapement		Total Inshore Run	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
6 11	163	163	0	0	163	163	163	163
6 12	738	901	0	0	738	901	738	901
6 13	1,520	2,421	0	0	1,520	2,421	1,520	2,421
6 14	3,167	5,588	0	0	3,167	5,588	3,167	5,588
6 15	5,320	10,908	0	0	5,320	10,908	5,320	10,908
6 16	1,894	12,802	0	0	1,894	12,802	1,894	12,802
6 17	0	12,802	0	0	0	12,802	0	12,802
6 18	49,038	61,840	0	0	49,038	61,840	49,038	61,840
6 19	90,362	152,202	2,814	2,814	93,176	155,016	93,176	155,016
6 20	121,801	274,003	4,752	7,566	126,553	281,569	126,553	281,569
6 21	267,785	541,788	10,764	18,330	278,549	560,118	278,549	560,118
6 22	274,210	815,998	11,844	30,174	286,054	846,172	286,054	846,172
6 23	136,288	952,286	8,160	38,334	144,448	990,620	147,448	993,620
6 24	0	952,286	12,666	51,000	12,666	1,003,286	312,866	1,306,486
6 25	214,810	1,167,096	86,154	137,154	300,964	1,304,250	464,264	1,770,750
6 26	256,030	1,423,126	155,994	293,148	412,024	1,716,274	473,824	2,244,574
6 27	892,636	2,315,762	104,244	397,392	996,880	2,713,154	1,318,080	3,562,654
6 28	8,000	2,323,762	189,030	586,422	197,030	2,910,184	1,307,130	4,869,784
6 29	788,271	3,112,033	872,598	1,459,020	1,660,869	4,571,053	1,993,069	6,862,853
6 30	1,006,188	4,118,221	1,156,544	2,615,564	2,162,732	6,733,785	1,443,032	8,305,885
7 1	827,384	4,945,605	982,752	3,598,316	1,810,136	8,543,921	1,489,036	9,794,921
7 2	2,033,217	6,978,822	792,090	4,390,406	2,825,307	11,369,228	2,932,307	12,727,228
7 3	256,172	7,234,994	767,352	5,157,758	1,023,524	12,392,752	1,617,144	14,344,372
7 4	930,082	8,165,076	1,022,172	6,179,930	1,952,254	14,345,006	2,136,434	16,480,806
7 5	1,832,096	9,997,172	1,052,682	7,232,612	2,884,778	17,229,784	2,215,458	18,696,264
7 6	817,722	10,814,894	1,120,800	8,353,412	1,938,522	19,168,306	2,614,842	21,311,106
7 7	1,321,071	12,135,965	1,060,116	9,413,528	2,381,187	21,549,494	2,358,587	23,669,694
7 8	1,560,663	13,696,628	1,096,986	10,510,514	2,657,649	24,207,144	2,475,449	26,145,144
7 9	2,145,008	15,841,636	1,133,386	11,643,900	3,278,394	27,485,538	2,393,394	28,538,538
7 10	1,810,284	17,651,920	785,496	12,429,396	2,595,780	30,081,318	2,331,938	30,870,476
7 11	465,997	18,117,918	581,298	13,010,694	1,047,295	31,128,614	1,553,637	32,424,114
7 12	1,502,458	19,620,376	422,862	13,433,556	1,925,320	33,053,934	2,037,122	34,461,234
7 13	1,412,615	21,032,992	526,986	13,960,542	1,939,601	34,993,534	1,869,801	36,331,040
7 14	1,321,429	22,354,422	487,746	14,448,288	1,809,175	36,802,710	1,235,399	37,566,440
7 15	843,886	23,198,308	250,632	14,698,920	1,094,518	37,897,230	955,482	38,521,924
7 16	691,635	23,889,944	131,004	14,829,924	822,639	38,719,870	697,949	39,219,870
7 17	302,354	24,192,298	347,250	15,177,174	649,604	39,369,474	149,604	39,369,474
7 18	180,000	24,372,298	224,808	15,401,982	404,808	39,774,284	404,808	39,774,284

[1] Catch estimates based on daily oral reports from buyers during the season.

Appendix Table 7. Age, length (mid-eye to tail fork, mm) and weight (round weight, kg) statistics for sockeye salmon caught during Port Moller, Bristol Bay, test fishing, 1984.

	Age Group								
	4 1	4 2	5 2	5 3	6 2	6 3	6 4	7 4	Total
Males									
Percent	0.30	7.90	10.40	25.00	0.00	9.40	0.10	0.10	53.20
Mean length	586.33	514.21	577.80	529.27		587.26	549.00	597.00	547.25
Std. error	1.33	2.78	3.23	1.29		3.13			1.11
Sample size	3	78	102	245	0	92	1	1	522
Mean weight	3.40	2.24	3.24	2.35		3.33	2.70	3.50	2.69
Std. error		0.08	0.09	0.03		0.08			0.03
Sample size	1	26	48	102	0	45	1	1	224
Females									
Percent	0.30	1.40	17.00	15.50	0.20	11.90	0.10	0.40	46.80
Mean length	553.00	506.43	561.43	524.47	597.00	568.50	496.00	575.50	549.42
Std. error	9.50	10.36	1.64	1.55	11.00	2.08		11.60	1.01
Sample size	3	14	167	152	2	117	1	4	460
Mean weight	2.37	1.93	2.81	2.17	3.40	2.84	2.04	2.72	2.58
Std. error	0.07	0.04	0.04	0.03	0.20	0.05			0.02
Sample size	2	8	62	58	2	42	1	1	176
Both Sexes									
Percent	0.60	9.30	27.40	40.50	0.20	21.30	0.20	0.50	100.00
Mean length	569.67	513.04	567.64	527.43	597.00	576.78	522.50	579.80	548.27
Std. error	4.80	2.83	1.59	0.99	11.00	1.80		9.28	0.76
Sample size	6	92	269	397	2	209	2	5	982
Mean weight	2.89	2.19	2.97	2.28	3.40	3.06	2.37	2.88	2.64
Std. error	0.05	0.06	0.04	0.02	0.20	0.05			0.02
Sample size	3	34	110	160	2	87	2	2	400

Appendix Table 8. Port Moller, Bristol Bay, chum salmon test fishing index points by station, 1984. Interpolated values are enclosed in brackets ([]).

	Station											
Date	1	2	3	4	5	6	7	8	9	10	11	TOTAL
6/12	0.00		0.00		0.00		4.69		0.00		0.00	4.69
6/13		0.48		0.00		0.58		0.00		0.00		1.07
6/14	0.00		0.00		0.00		3.21		1.58		1.55	6.34
6/15		2.02		0.00		0.00		2.14		3.56		7.72
6/16	0.52		0.49		0.51		1.04		3.41		1.08	7.06
6/17		0.56		0.00		0.45		0.00		3.69		4.70
6/18	0.00		0.00		0.96		4.48		0.58		0.00	6.02
6/19		1.70		0.57		0.00		3.46		1.75		7.48
6/20	[0.00]		[0.00]		1.59		0.59		[1.00]		[0.00]	3.18[1]
6/21		0.00		0.54		0.54		1.08		.51		2.67
6/22	0.00		0.60		0.51		[0.00		[1.00]		[0.00]	2.11[1]
6/23		[1.40]		[0.60]		[0.40]		[1.10]		[1.60]		5.10[1]
6/24	1.08		1.57		0.98		0.90		0.00		0.00	4.52
6/25		4.66		1.08		0.55		1.06		0.00		7.35
6/26	2.97		1.98		0.00		0.00		7.56		1.15	13.67
6/27		0.00		0.00		0.00		0.00		2.73		2.73
6/28	2.80		0.59		0.57		1.07		2.29		0.00	7.32
6/29		2.50		0.00		1.14		0.00		0.00		3.64
6/30	[2.00]		[0.30]		0.00		0.00		0.00		[0.00]	2.30[1]
7/ 1		0.00		2.29		0.00		1.68		2.65		6.62
7/ 2	1.13		0.00		0.54		0.00		0.57		0.00	2.24
7/ 3		0.00		0.00		0.00		0.54		0.00		.54
7/ 4	0.54		0.55		[0.00]		[0.00		[0.00]		[0.00]	1.09[1]
7/ 5		0.51		1.08		0.00		0.00		0.00		1.59
Total	11.05	13.82	6.08	6.16	5.65	3.66	15.98	11.07	17.99	16.50	3.79	111.73
Percent	10	12	5	6	5	3	14	10	16	15	3	100

[1] Totals include interpolated values.

1984 NUSHAGAK AND EGEGIK DISTRICT TEST FISHING

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INTRODUCTION

District test fishing has been conducted both within commercial fishing boundaries and in areas adjacent to these boundaries. This phase of the test fishing program was first initiated in 1962 for use in Naknek-Kvichak District, but similar programs have also been developed for use in Egegik, Ugashik, and Nushagak Districts (Nelson, in press).

The primary goal of district test fishing has been to monitor abundance, distribution, and movement patterns of sockeye salmon within a district during closed fishing periods. This information has been used by fishery managers to set and adjust fishing periods. In Nushagak District test fishing has been used to index salmon abundance when milling and holding begin to move into the various river systems. For example, if a large amount of fishing effort is present, fishery closures may be needed to protect milling salmon until they resume migration into their spawning systems. On the other hand, if large concentrations of salmon are present, fishery openings of sufficient duration may be needed to allow maximum harvest.

In 1984, the district test fishing program provided critical information on abundance and movement patterns of sockeye salmon within both Nushagak and Egegik Districts that helped managers achieve spawning escapement goals and optimize harvest of the resource.

METHODS

District test fishing was conducted only during closed fishing periods, since commercial landings provided similar information during open periods. Two chartered fishing vessels, each with an Alaska Department of Fish and Game observer aboard, were used for test fishing. One vessel fished within Nushagak District, while the other fished within Egegik District. Test

drifts of ten minutes or less were made, since it has proven most useful to make several short drifts and fish several locations within each district to provide information on salmon distribution, abundance, and movement. Test fishing was done with 18 to 91 m (10 to 50 fm) long sections of gill net having a stretched mesh size of 137 mm (5-3/8 in). Salmon catch per drift was adjusted according to amount of gear fished and duration of drift so that comparisons of catch per unit of effort could be made among locations. Information from each drift was immediately relayed to the area office via radio, so that timely management decisions could be made.

RESULTS AND DISCUSSION

Nushagak District

A total of 1,457 sockeye salmon were caught by the chartered fishing vessel during 78 drifts within Nushagak District over a ten-day period, 29 June through 8 July (Table 1, Figure 1, Appendix Table 1).

Total return of sockeye salmon through 27 June was 993,000 and escapement to the major systems was progressing on schedule. However, the 67% increase in the escapement goal for the Nuyakuk River (past goal, 300,000; revised goal, 500,000) made it necessary to carefully monitor run abundance and timing. Test fish indices on 29 June indicated that sockeye salmon abundance within the District was not adequate to allow additional fishing time (Table 1). However, test fish indices on 30 June increased dramatically and indicated that a sizable body of sockeye salmon had begun to move past the upper District boundary and into the rivers. Based upon this information a 12-hour fishing period was allowed during 1 July.

Test fishing conducted on 2 and 3 July indicated that sockeye salmon were still entering the District and moving into the rivers, but only in moderate numbers. By 3 July, catch and escapement of sockeye salmon had reached 1.8 million, but it was apparent that total run size would be much less than the pre-season forecast estimate of 5.2 million. Therefore, only a 12-hour fishing period was allowed during 4 and 5 July.

On 6 July, test fishing indicated that sockeye salmon abundance within the District had increased considerably; good indices were obtained from Ekuk Bluff to the upper District boundary (Table 1, Figure 1). Since 61% of the escapement goal had already entered Wood River by this date and sockeye salmon continued to enter and move through the District, another 12-hour fishery opening was allowed on 7 July.

Test fishing results on 8 July indicated that moderate numbers of sockeye salmon continued to move past the upper District boundary and into the rivers. Since Wood River escapement was projected to reach 80% of the season goal by 9 July, additional fishing time was allowed.

District test fishing provided important information on fish movement and abundance that allowed managers to maximize the commercial harvest while

Table 1. Summary of Nushagak District sockeye salmon test fishing indices by area and date, Bristol Bay, 1984. Indices expressed as number of sockeye salmon caught per 100 fathoms of gill net fished per hour. Index values followed by asterisk (*) were mean of two consecutive drifts in same area.

	Date										
	June 29		June 30		July 2		July 3		JULY 6		JULY 8
Index Area	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	P.M.
Nushagak River				5,760							
Wood River											
Kanakanak Beach	40		2,540*		873		754*		2,520*		80*
Grassy Island	19		8,640	1,800	175		53		6,880	6,462	2,100*
Nushagak Point	0	34	5,160		320		517			2,580	3,376
Coffee Point	100*			2,160		576	120	1,813		640	
Combine Flats			7,040	2,256	303*	584	360	480		1,007*	2,839*
Clarks Point		946					152			560	
Ekuk Bluff	206	215*	204*		226			377		2,092*	
Schooner Channel,NW	533		28		185*			222*		945*	
Ships Channel,NW	100		23			57		366			
Middle Channel,NW	98			680		55		286		84*	
West Channel,NW						20		63		0	

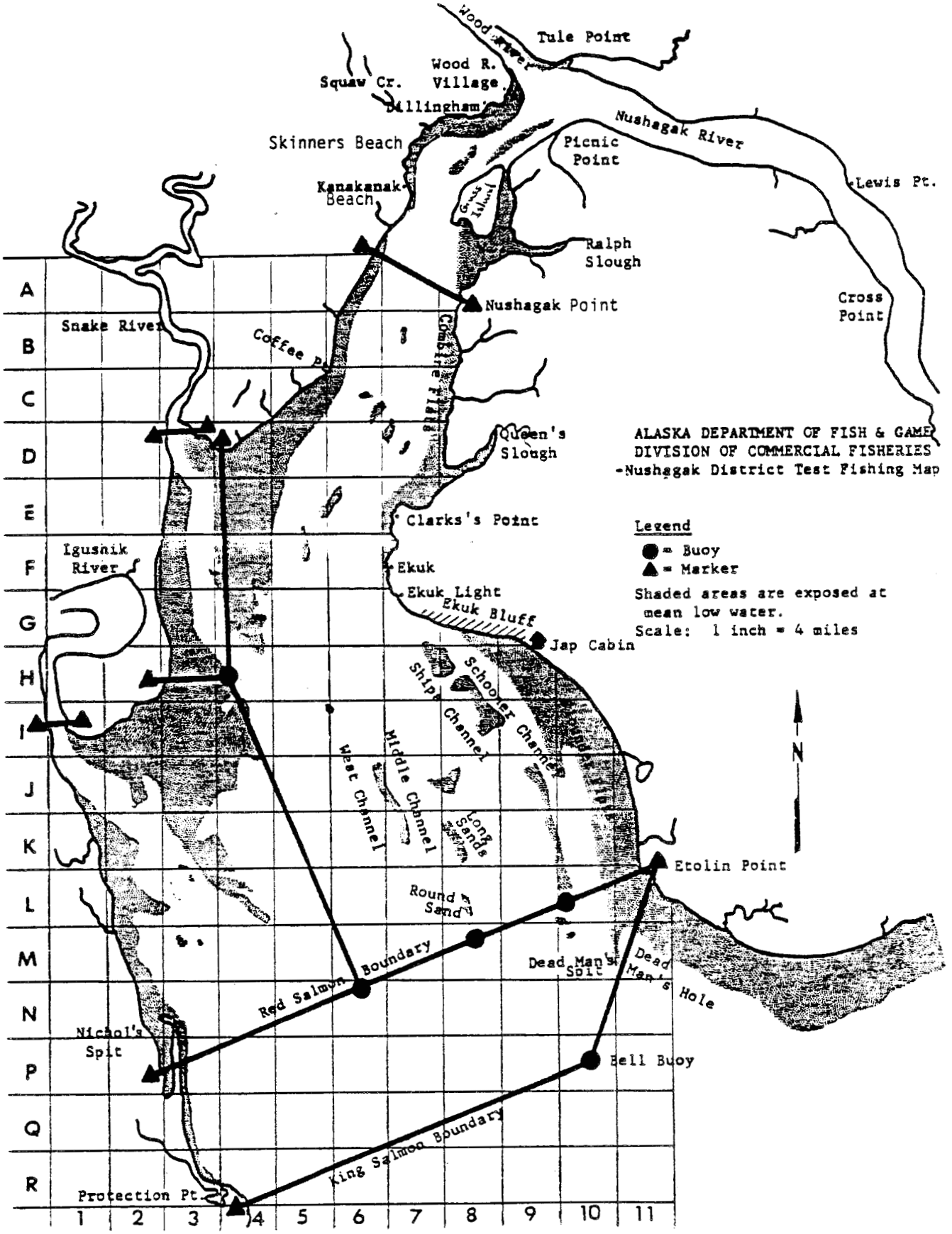

Figure 1. Nushagak test fishing areas.

still achieving desired escapement goals for all systems by the end of the season.

Egegik District

A total of 630 sockeye salmon were caught by the chartered fishing vessel during 10 drifts within Egegik District over a two-day period, 5 and 6 July (Table 2, Figure 2, Appendix Table 2).

Total return of sockeye salmon through 4 July totaled 3.0 million, about 86% of the total pre-season forecast estimate. However, only 61% of the escapement goal had been obtained by this date and both tower counts and river test fishing catches indicated that few sockeye were moving into the Egegik River. District test fishing on 5 July indicated that sockeye salmon were distributed throughout the outer portion of the District with the greatest concentration located near Red Bluff (Table 2, Figure 2). Results from the following day, 6 July, indicated that sockeye salmon abundance had increased in the north and south District boundary areas. Based on this information a 13-hour fishery opening was allowed on 7 July.

District test fishing provided information which indicated that the sockeye salmon entry pattern was bimodal and allowed the manager to maximize the commercial harvest while still achieving the desired escapement goal (1.0 million) by the end of the season.

Table 2. Summary of Egegik District sockeye salmon test fishing indices by area and date, Bristol Bay, 1984. Indices expressed as number of sockeye salmon caught per 100 fathoms of gill net fished per hour. Index values followed by asterisk (*) were mean of two consecutive drifts in same area.

	Date	
Index Area	July 5	July 6 [1]
Coffee Point	133	
Red Bluff	1,509	
Ships Channel	393 *	266
North Marker	278	834
South Marker	155	215
Two Miles N of North Marker		191

[1] Several small sockeye salmon were noted to have dropped out of the net during each drift but were not included when calculating indices.

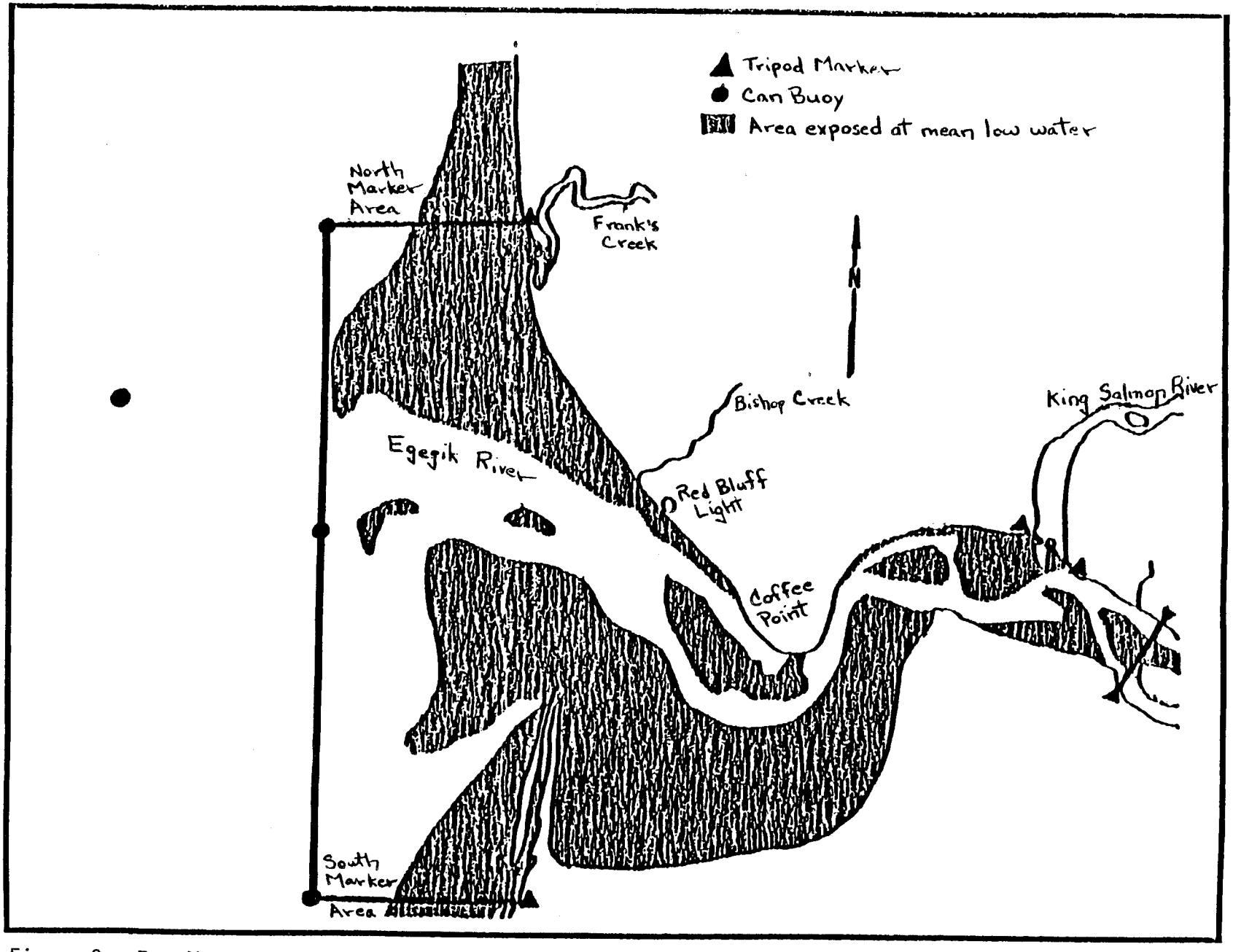

Figure 2. Egegik test fishing areas.

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APPENDIX

Appendix Table 1. Nushagak District test fishing catches, fishing times, gill net lengths, sockeye salmon indices, and tide stages by date and index area, Bristol Bay, 1984.

Date	Set	Index Area[1]	Gill Net Length (m)[2]	Drift Time (min)	Sockeye Salmon Catch	Sockeye Salmon Index[3]	Chinook Salmon Catch	Chum Salmon Catch	Tide Stage
					Trip No. 1				
June 29	1	Grassy	91	6.50	1	19	0	0	EBB
	2	Kanak	91	9.00	3	40	2	4	EBB
	3	B7	91	8.50	0	0	0	0	EBB
	4	D7	91	12.00	0	0	0	0	EBB
	5	D8	91	12.00	20	200	0	1	EBB
	6	F7	91	14.00	24	206	0	0	EBB
	7	G8	91	9.00	40	533	1	4	EBB
	8	J7	91	11.00	9	98	1	5	LOW SLACK
	9	I8	91	12.00	10	100	0	2	FLOOD
	10	G7	91	13.00	14	129	0	1	FLOOD
	11	F6	91	10.00	25	300	3	18	FLOOD
	12	E6	91	8.50	67	946	2	33	FLOOD
	13	A7	91	10.50	3	34	0	0	FLOOD
					Trip No. 2				
June 30	1	P. Pan	18	3.00	2	2,600	0	0	EBB
	2	Grassy	45	1.25	54	8,640	0	0	EBB
	3	Kanak	45	2.80	31	2,480	0	0	EBB
	4	B8	91	3.00	129	5,160	0	0	EBB
	5	C7	45	3.00	88	7,040	0	0	EBB
	6	F7	45	5.00	8	384	0	0	EBB
	7	G8	45	10.00	1	24	0	0	EBB
	8	G7	91	17.00	4	28	0	0	EBB
	9	H7	91	16.00	3	23	0	0	LOW SLACK
	10	I7	91	6.00	24	680	0	0	FLOOD
	11	D7	45	5.00	47	2,256	0	0	FLOOD
	12	B6	45	3.00	27	2,160	0	0	FLOOD
	13	Grassy	18	4.00	12	1,800	0	2	FLOOD
	14	Picnic	45	2.00	48	5,760	0	0	FLOOD
					Trip No. 3				
July 2	1	Grassy	45	2.75	2	175	0	0	EBB
	2	Kanak	45	2.75	10	873	0	1	EBB
	3	A8	45	4.50	6	320	0	1	EBB
	4	C7	45	5.75	0	0	0	0	EBB
	5	D7	45	4.75	12	606	0	0	EBB
	6	G7	45	5.25	5	229	0	0	EBB
	7	H8	45	7.25	11	364	1	0	EBB
	8	H8	91	20.50	1	6	0	0	EBB
	9	I8	91	16.75	8	57	0	0	EBB
	10	J7	91	22.00	10	55	0	19	LOW SLACK
	11	J6	91	41.75	7	20	2	7	FLOOD
	12	D7	45	5.75	14	584	1	3	FLOOD
	13	B6	45	5.00	12	576	0	2	FLOOD

-Continued-

Appendix Table 1. Nushagak District test fishing catches, fishing times, gill net lengths, sockeye salmon indices, and tide stages by date and index area, Bristol Bay, 1984 (continued).

Date	Set	Index Area[1]	Gill Net Length (m)[2]	Drift Time (min)	Sockeye Salmon Catch	Sockeye Salmon Index[3]	Chinook Salmon Catch	Chum Salmon Catch	Tide Stage
					Trip No. 4				
July 3	1	P. Pan	18	2.25	1	267	0	0	EBB
	2	Grassy	45	4.50	1	53	0	0	EBB
	3	Kanak	45	4.25	22	1,242	0	2	EBB
	4	A8	45	3.25	7	517	0	1	EBB
	5	A6	45	4.00	2	120	0	2	EBB
	6	C7	45	4.00	6	360	0	0	EBB
	7	E7	45	4.75	3	152	0	0	EBB
	8	F7	45	7.00	11	377	0	1	EBB
	9	G8	45	6.25	6	230	0	0	EBB
	10	H8	91	18.00	32	213	0	3	EBB
	11	I7	91	24.25	74	366	0	10	LOW SLACK
	12	J7	91	13.00	31	286	0	3	FLOOD
	13	I6	91	11.50	6	63	1	0	FLOOD
	14	D8	45	5.50	11	480	1	0	FLOOD
	15	B6	45	2.25	17	1,813	0	1	FLOOD
					Trip No. 5				
July 6	1	P. Pan	18	2.00	10	3,000	0	0	FLOOD
	2	Kank	45	2.00	17	2,040	1	2	HIGH SLACK
	3	Grassy	45	1.50	43	6,880	0	0	EBB
	4	A8	45	4.00	43	2,580	0	1	EBB
	5	A6	45	3.00	8	640	0	0	EBB
	6	C7	45	4.60	22	1,173	0	0	EBB
	7	D8	45	3.00	7	560	0	0	EBB
	8	F6	45	5.25	18	823	0	0	EBB
	9	G7	45	2.00	28	3,360	0	0	EBB
	10	H8	91	3.25	51	1,883	0	1	EBB
	11	H8	91	18.75	1	6	0	7	EBB
	12	I7	91	16.25	19	140	4	9	LOW SLACK
	13	I6	91	25.00	6	29	0	3	FLOOD
	14	H5	91	9.00	0	0	0	0	FLOOD
	15	D7	45	6.00	21	840	0	0	FLOOD
	16	Grassy	45	1.30	35	6,462	0	0	FLOOD
					Trip No. 6				
July 6	1	P. Pan	18	2.00	0	0	0	0	EBB
	2	Kank	45	3.00	2	160	0	0	EBB
	3	Grassy	45	3.25	11	812	0	0	EBB
	4	A8	45	2.63	37	3,376	0	0	EBB
	5	C8	45	2.75	7	611	0	1	EBB
	6	C8	18	2.25	19	5,067	0	0	EBB
	7	Grassy	45	2.13	30	3,388	0	0	EBB

[1] Grassy=Grassy Island; Kanak=Kanakanak Beach; P. Pan=Peter Pan Cannery; Picnic=Picnic Point; number and letter codes=grid locations on Nushagak District test fishing map.

[2] Gill net stretched mesh size was 134 mm (5-3/8 in).

[3] Index expressed as number of sockeye salmon caught in a 182 m (600 ft) long gill net fished for one hour.

Appendix Table 2. Egegik District test fishing catches, fishing times, gill net lengths, sockeye salmon indices, and tide stages by date and index area, Bristol Bay, 1984.

Date	Set	Index Area	Gill Net Length (m)[1]	Drift Time (min)	Sockeye Salmon Catch	Sockeye Salmon Index[2]	Chinook Salmon Catch	Chum Salmon Catch	Tide Stage
					Trip No. 1				
July 5	1	Coffee Pt.	91	10.90	12	133	0	0	EBB
	2	Red Bluff	91	9.90	125	1,509	0	0	EBB
	3	N. Marker	91	11.70	54	278	0	0	EBB
	4	S. Marker	182	12.40	32	155	0	0	LOW SLACK
	5	Entrance	182	9.90	65	394	0	0	FLOOD
	6	Entrance	182	11.80	77	393	0	0	FLOOD
					Trip No. 2				
July 6	1	3.3 Km North of N. Marker	182	10.10	32	191	0	0	EBB
	2	S. Marker	182	10.10	36	215	0	0	LOW SLACK
	3	N. Marker	182	10.70	148	834	0	0	FLOOD
	4	Entrance	182	11.10	49	266	0	0	FLOOD

[1] Gill net stretched mesh size was 134 mm (5-3/8 in).

[2] Index expressed as number of sockeye salmon caught in a 182 m (600 ft) long gill net fished for one hour.

1984 BRISTOL BAY SOCKEYE SALMON ESCAPEMENT TEST FISHING

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INTRODUCTION

The Bristol Bay sockeye salmon *(Oncorhynchus nerka)* escapement test fishing program, which began in 1960 (Paulus 1968), has been used to provide an early estimate of spawning escapement past the commercial fisheries. These estimates are needed because sockeye salmon migration time from fishing districts to clear water areas where counting towers are sited may be ten or more days within some river systems. Such delays in obtaining visual counts of escapement would seriously hinder fishery management, especially since 80% of the salmon harvest usually occurs within a two-week period.

During 1984, forecasts of sockeye salmon escapements using river test fishing data were made for the Kvichak, Egegik, Ugashik, and Igushik Rivers. This report summarizes that data and describes forecasting results.

METHODS

Test fishing sites were located in the lower section of each river, as close as possible to the fishing district boundary but above areas where salmon milled about or flushed up and down with the tides (Figure 1). Gill nets 46 m (25 fm) long and 28 meshes deep, with 137 mm (5-3/8 in) stretched mesh size, were drifted from a boat in the Kvichak, Egegik, and Ugashik Rivers, or set with one end staked to shore in the Igushik River. Fishing time was usually 30 minutes or less to minimize catches while still obtaining good estimates of sockeye salmon escapement.

Two sites, on opposite sides of the river, were fished at the start of each flood tide on the Kvichak River, 1-1/2 hours before each high slack on the Egegik River, and 1-1/2 hours prior to each low slack on the Ugashik River. A single site on the south bank of the Igushik River was fished 15 minutes

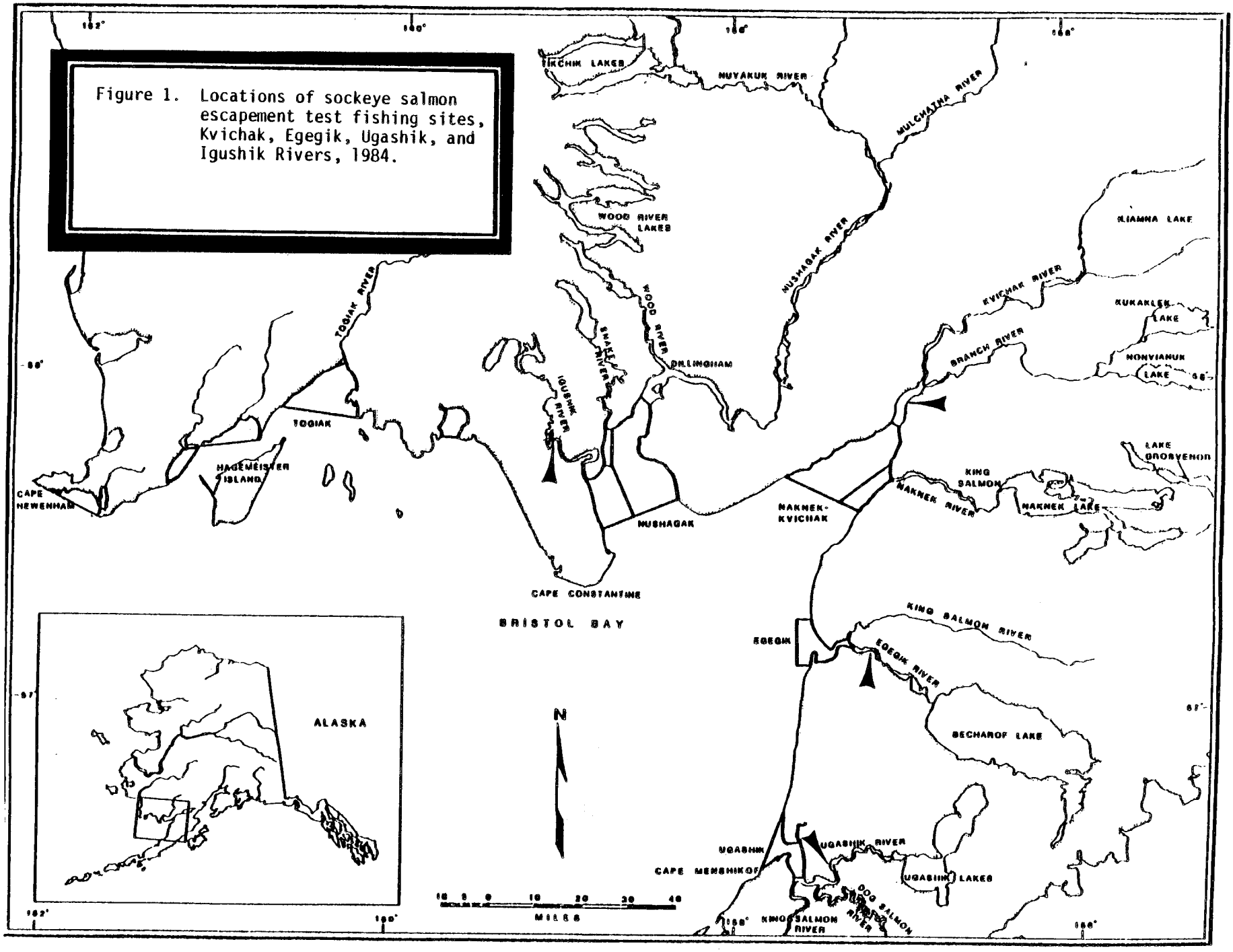


Figure 1. Locations of sockeye salmon escapement test fishing sites, Kvichak, Egegik, Ugashik, and Igushik Rivers, 1984.

before high slack. Therefore, a maximum of four sets per day were made on the Kvichak, Egegik, and Ugashik Rivers and two sets per day on the Igushik River.

Catch per unit of effort (CPUE) for each set was expressed as the number of sockeye salmon caught per fathom of net used per hour of fishing time. The daily test fish index was the mean CPUE of all individual sets from that day. A minimum of ten sockeye salmon caught during each set were weighed (round weight, kg) and measured (mid-eye to tail fork length, mm). Additionally, scale samples for age interpretation were taken from sockeye salmon caught at all locations except the Igushik River.

Forecasts of cumulative escapement were made by multiplying cumulative daily indices by an escapement per index point (EPI) value calculated from either models based upon size of sockeye salmon caught (Appendix Table 1 through 4 and Appendix Figures 1 through 8) or lag time analysis.

During 1984, EPI values based upon sockeye salmon size were calculated from power curve equations using running mean length for projects on Kvichak, Egegik, and Ugashik Rivers (Yuen in press):

1.1. $EPI = a\ X^{b}$, where

X = running mean length (mm),
a and b = constants; and

linear regression equations using running mean length or weight for test fishing on Kvichak (Yuen in press) and Igushik Rivers (Bucher and Frederickson in press), respectively.

1.2. $EPI = a + bX$, where

X = running mean length (mm) or weight (kg),
a and b = constants.

During 1984, EPI values based on lag time analysis were computed by dividing cumulative tower counts by cumulative test fishing indices for the most recent date:

2.1. $$EPI = \frac{\sum_{i=1}^{t} S_i}{\sum_{i=1}^{t-d} C_i}$$, where

d = lag time (days),
C = daily indices, and
S = daily tower counts.

The lag time used for calculating EPI was usually selected by comparing cumulative curves of test fish indices with escapement counts, and finding the lag time resulting in the smallest squared sum of errors between the two curves. Lag times equal to zero or considered to be excessively large were rejected.

Models based upon sockeye salmon size were used to forecast escapements during the first portion of the season. As daily test fish and tower count data accumulated, lag time analysis was also used to forecast escapements. By the second week of test fishing, forecasts based upon lag time analysis usually replaced those based upon size models. Aerial surveys were flown periodically by management biologists as a further check on the accuracy of escapement forecasts from test fishing. This information was often used to select appropriate lag times, when it was difficult to select one based solely upon minimizing squared sums of errors.

After the season, lag time analysis was done using a least squares fit method modified from Mundy and Mathisen (1981):

$$2.2. \quad EPI = \frac{\sum_{i=1}^{t} S_i C_{i-d}}{\sum_{i=1}^{t-d} C_i^2} .$$

Forecasts from this method were compared to those obtained from the method used during the season to determine which were more accurate.

RESULTS AND DISCUSSION

Kvichak River

Test fishing began 20 June and ended 12 July. A total of 2,110 sockeye salmon were caught, resulting in 45,584.10 cumulative daily index points (Appendix Table 5). Sockeye salmon mean length and weight were 518.94 mm and 2.28 kg, respectively (Table 1 and Appendix Table 6).

Power curve (equation 1.1) and linear regression (equation 1.2) models based upon running mean length were used to forecast escapements until 28 June, when results were averaged with that from lag time analysis. After this date, except for 1 July when results of both length models and lag time analysis were again averaged, lag time analysis was used exclusively to forecast escapements since results from length models began to fall below actual tower counts. By the end of the season, 12 July, the cumulative tower count was two million sockeye salmon greater than that forecasted by length models (7,294,501 and 7,752,134 for the power curve [equation 1.1] and linear regression [equation 1.2] models, respectively) (Table 1 and Figure 2).

Table 1. Sockeye salmon escapement test fishing data, including daily estimates of spawning escapement made during the season based upon running mean length, Kvichak River, 1984.

DATE	FISHING TIME	CATCH	INDEX	CUMULATIVE INDEX	MEAN WEIGHT	MEAN LENGTH	RUNNING MEAN LENGTH	ESTIMATED CUMULATIVE ESCAPEMENT (THOUSANDS) POWER CURVE[1]	ESTIMATED CUMULATIVE ESCAPEMENT (THOUSANDS) LINEAR REG.[2]
6 20	45.62	0	0.00	0.00	0.00	0.00	0.00	0	0
6 21	102.66	0	0.00	0.00	0.00	0.00	0.00	0	0
6 22	92.84	0	0.00	0.00	0.00	0.00	0.00	0	0
6 23	95.03	16	19.05	19.05	1.90	503.57	503.57	5	8
6 24	36.25	107	1268.91	1287.96	2.28	523.01	522.73	141	124
6 25	43.54	25	240.91	1528.87	2.10	514.30	521.40	232	210
6 26	69.76	33	329.61	1858.48	2.05	505.30	518.54	305	322
6 27	54.74	93	1981.39	3839.86	2.35	524.68	518.57	629	664
6 28	8.32	155	5821.91	9661.78	2.33	514.48	515.47	2,565	2,570
6 29	13.94	178	5000.45	14662.23	2.29	525.82	519.55	2,260	2,428
6 30	47.64	96	1066.79	15729.02	2.14	513.91	519.11	2,491	2,655
7 1	41.55	99	2135.89	17864.91	2.34	546.00	519.36	3,159	3,382
7 2	10.85	126	3423.34	21288.26	2.24	517.52	519.00	3,395[3]	3,612[3]
7 3	21.89	216	5137.62	26425.87	2.19	515.44	518.18	4,151	4,416
7 4	5.14	56	2996.11	29421.98	2.30	527.68	518.78	4,756	5,039
7 5	12.64	99	1967.97	31389.96	2.11	513.18	518.35	5,210	5,475
7 6	9.95	120	2895.17	34285.12	2.28	523.14	518.83	5,524[4]	5,858[4]
7 7	10.31	153	3776.34	38061.46	2.52	528.59	519.96	5,993	6,432
7 8	15.80	136	2671.03	40732.49	2.47	520.98	520.04	6,110	6,680
7 9	37.75	79	538.28	41270.77	2.13	513.14	519.94	6,229	6,731
7 10	58.57	37	216.93	41487.70	2.21	517.33	519.92	6,271	6,780
7 11	32.16	195	2111.55	43599.25	2.10	507.23	519.22	6,845	7,412
7 12	12.96	91	1984.85	45584.10	2.07	508.28	518.94	7,295	7,752
TOTAL		2110	45584.10						
MEAN					2.28	518.94			

[1] $Y = (4.0123 \times 10^{85}) \times [-30.7176]$, where Y = EPI, X = mean length (mm), and $R^2 = 0.8252$.

[2] $Y = 4036.7140 - 7.4474 X$, where Y = EPI, X = mean length (mm), and $R^2 = 0.7447$.

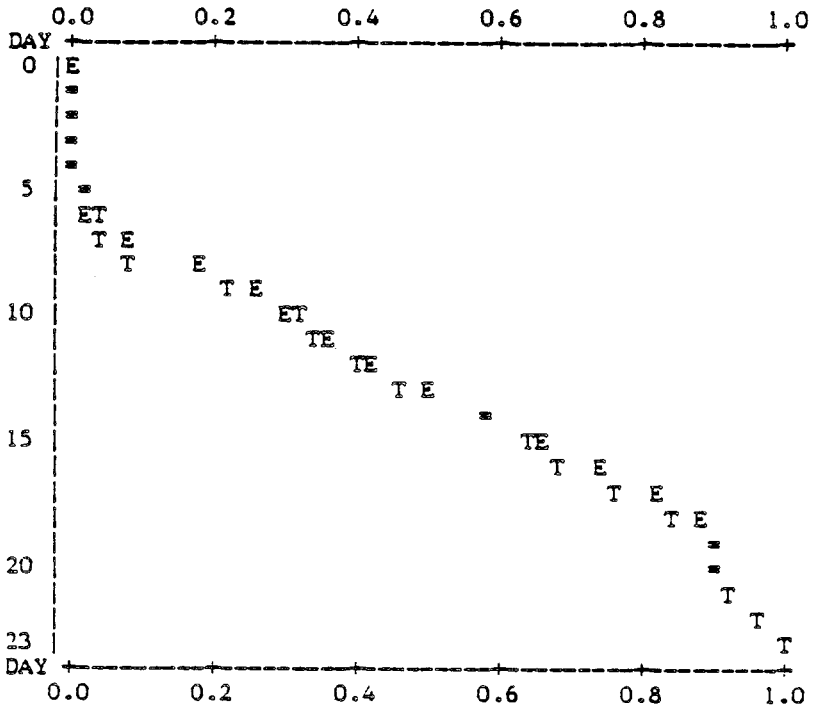
[3] Escapement estimates based upon running mean length until 2 July. Estimates from 2 July until end of season based upon lag time analysis (Table 2).

[4] Escapement estimates based upon running mean length less than actual tower counts by 6 July.

KVICHAK

7/12 ACCUMULATED ESCAPEMENT = 9,358,056
7/12 ACCUMULATED INDEX= 45584.09766 (2 SETS ON LAST DAY)
MEAN LENGTH = 518.94 FISH/INDEX = 160 FORECAST = 7,294,501 (POWER CURVE)
FISH/INDEX = 170 FORECAST = 7,752,134 (LINEAR REGRESSION)
MEAN WEIGHT =2.28 KG (5.02 LBS)

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/12
1	214.638	9,784,080	3286382.75	9358056.00
2	225.562	10,282,048	1651318.37	9358056.00
3	226.748	10,336,094	1517125.25	9358056.00
4	229.744	10,472,684	3585887.75	9358056.00
5	245.867	11,207,623	5008327.50	9358056.00



INDEX	FORECAST	ACTUAL
0.00	0.00	216.00
0.00	0.00	474.00
0.00	0.00	900.00
0.00	0.00	17478.00
19.05	4319.47	86424.00
1287.96	292041.25	120630.00
1528.87	346667.75	133134.00
1858.48	421405.34	804384.00
3839.86	870680.50	1821438.00
9661.78	2190786.50	2599638.00
14662.23	3324628.00	3116016.00
15729.02	3566521.00	3630096.00
17864.91	4050830.00	4319676.00
21288.26	4827065.00	5113272.00
26425.87	5992008.50	5967852.00
29421.98	6671370.00	6787332.00
31389.96	7117603.50	7581468.00
34285.12	7774076.00	8436888.00
38061.46	8630354.00	8992848.00
40732.49	9236003.00	9222042.00
41270.77	9358056.00	9358056.00
41487.70	9407246.00	0.00
43599.25	9886034.00	0.00
45584.10	10336094.00	0.00
INDEX	FORECAST	ACTUAL

TIME LAG = 3

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	23
ESCAPEMENT	E	23

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 2. Computer printout showing estimate of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimate of lag time by cumulative escapement divided by cumulative index method; plot of cumulative index and escapement curves on last day of test fishing, Kvichak River, 1984.

At the end of the season a three-day lag time minimized the squared sum of errors between escapement estimates and tower counts (equation 2.1) (Figure 2). This lag time produced an escapement forecast of 10,336,094 for 15 July, only 2% more than the cumulative tower count of 10,111,152 for that day. During the season a two-day lag time was usually selected (Table 2). This lag time produced escapement estimates which fit cumulative tower counts almost as well as a three-day lag time (Table 2). Daily percent errors of forecasts based upon a two-day lag time ranged from 212 on 24 June to less than one towards the end of the project.

The least square method of estimating lag time (equation 2.2) did not produce a more accurate forecast after the season than that produced by the method used during the season (equation 2.1). Although lag times of two and three days still had the smallest sums of errors squared (Figure 3), resulting EPI values produced forecasts which were 8 and 17% lower, respectively, than corresponding tower counts two and three days later.

Egegik River

Test fishing began 18 June and continued through 12 July. A total of 1,912 sockeye salmon were caught resulting in 26,947.22 cumulative daily index points (Appendix Table 7). Sockeye salmon mean length and weight were 543.74 mm and 2.60 kg, respectively (Table 3 and Appendix Table 8).

A power curve model (equation 1.1) based upon running mean length was used to forecast escapements until 1 July, except for 24 June when results were averaged with that from lag time analysis. On 2 July an aerial survey estimate was used to estimate escapement below the tower. After this date, lag time analysis was used exclusively to forecast escapements since results from the length model appeared to be excessive when compared to actual tower counts. The length model forecast on the last day of test fishing (1,912,960), 12 July, was 71% greater than the cumulative tower count for that day (Table 3 and Figure 4), and 64% greater than the final cumulative tower count on 20 July.

At the end of the season a three-day lag time minimized the squared sums of errors between escapement estimates and tower counts (equation 2.1) (Figure 4). This lag time produced an escapement forecast of 1,140,139 for 15 July, only 1% less than the cumulative tower count of 1,151,028 for that day. During the season a two or three-day lag time was selected (Table 4). Daily percent errors of forecasts during the season ranged from 264 on 24 June to less than one towards the end of the project.

The least square method of calculating lag time (equation 1.2) did not produce a more accurate forecast after the season than that produced by the method used during the season. Although lag times of two and three days still had the smallest sums of errors squared (Figure 5), resulting EPI values produced forecasts which were 18 and 13% less, respectively, than corresponding tower counts two and three days later.

Table 2. Sockeye salmon spawning escapement estimated during the season based upon lag time analysis of test fishing data, Kvichak River, 1984.

WITHIN SEASON FORECAST			ACTUAL ESCAPEMENT		
DATE	LAG (DAYS)	ESCAPEMENT (THOUSANDS)	DATE PLUS LAG	CUMULATIVE TOWER COUNT (THOUSANDS)	PERCENT ERROR OF FORECAST
6 24	1	54,451	6 25	17,478	212
6 25	1 OR 2	711,739[1]	6 27	804,384	-12
6 26	2	124,706[1]	6 28	133,134	-6
6 27	2	378,317[1]	6 29	804,384	-53
6 28	4	1,707,442[2]	7 2	3,116,016	-45
6 29	1	1,266,219[1]	6 30	1,821,438	-30
6 30	2	2,965,235	7 2	3,116,016	-5
7 1	4	3,591,536[2]	7 5	5,113,272	-30
7 2	2	4,217,334	7 4	4,319,676	-2
7 3	2	5,289,161	7 5	5,113,272	3
7 4	2 OR 3	6,542,128	7 7	6,787,332	-4
7 5	2	6,073,797	7 7	6,787,332	-11
7 6	3	7,742,735	7 9	8,436,888	-8
7 7	2	8,376,873	7 9	8,436,888	-1
7 8	2	9,007,175	7 10	8,992,848	<1
7 9	2	9,153,925	7 11	9,222,042	-1
7 10	2	9,199,312	7 12	9,358,056	-2
7 11	1	9,691,121	7 12	9,358,056	4
7 12	1 OR 2	10,032,774	7 14	10,031,868	<1

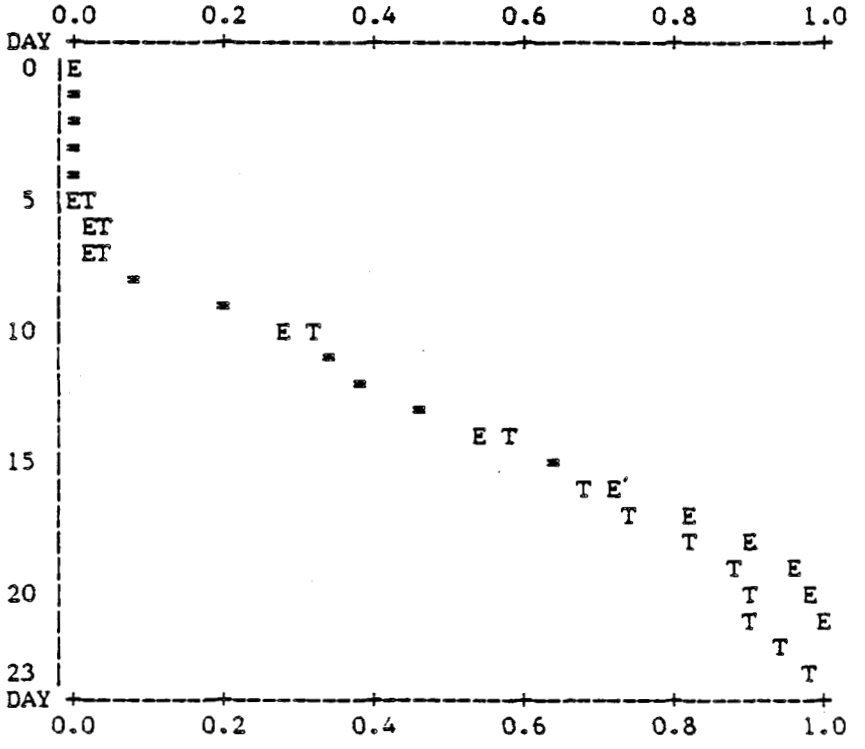
[1] Escapement estimate based upon lag time analysis not used during season.

[2] Lag time estimate averaged with power curve estimate to calculate escapement estimate used during season.

KVICHAK

7/12 ACCUMULATED ESCAPEMENT = 9,358,056
7/12 ACCUMULATED INDEX= 45584.09766 (2 SETS ON LAST DAY)
MEAN LENGTH = 518.94 FISH/INDEX = 160 FORECAST = 7,294,501 (POWER CURVE)
FISH/INDEX = 170 FORECAST = 7,752,134 (LINEAR REGRESSION)
MEAN WEIGHT =2.28 KG (5.02 LBS)

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/12
1	183.877	8,381,855	23287092.00	8016888.00
2	202.602	9,235,439	3670325.50	8405501.00
3	183.734	8,375,331	3382382.50	7582828.00
4	159.556	7,273,204	7050637.50	6499103.00
5	161.277	7,351,676	10807695.00	6138447.50



INDEX	FORECAST	ACTUAL
0.00	0.00	210.00
0.00	0.00	216.00
0.00	0.00	474.00
0.00	0.00	900.00
19.05	3859.51	17478.00
1287.96	260942.80	86424.00
1528.87	309752.31	120630.00
1858.48	376531.34	133134.00
3839.86	777964.75	804384.00
9661.78	1957497.37	1821438.00
14662.23	2970600.00	2599638.00
15729.02	3186734.75	3116016.00
17864.91	3619471.25	3630096.00
21288.26	4313048.00	4319676.00
26425.87	5353940.50	5113272.00
29421.98	5960959.00	5967852.00
31389.96	6359674.50	6787332.00
34285.12	6946241.50	7581468.00
38061.46	7711337.00	8436888.00
40732.49	8252493.50	8992848.00
41270.77	8361549.50	9222042.00
41487.70	8405501.00	9358056.00
43599.25	8833305.00	0.00
45584.10	9235439.00	0.00

INDEX	FORECAST	ACTUAL

TIME LAG = 2

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	23
ESCAPEMENT	E	23

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 3. Computer printout showing estimate of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimate of lag time by least squares method; plot of cumulative index and escapement curves on last day of test fishing, Kvichak River, 1984.

Table 3. Sockeye salmon escapement test fishing data, including daily estimates of spawning escapement made during the season based upon running mean length, Egegik River, 1984.

DATE	FISHING TIME	CATCH	INDEX	CUMULATIVE INDEX	MEAN WEIGHT	MEAN LENGTH	RUNNING MEAN LENGTH	ESTIMATED CUMULATIVE ESCAPEMENT (THOUSANDS) FROM POWER CURVE [1]
6 18	81.00	25	116.14	116.14	2.88	562.30	562.30	—
6 19	100.23	5	12.84	128.98	1.77	498.42	555.94	7
6 20	113.70	20	41.49	170.47	2.13	516.00	546.22	11
6 21	111.11	16	36.47	206.94	1.98	504.75	538.91	16
6 22	112.70	13	29.60	236.54	2.10	513.24	535.70	20
6 23	90.20	19	85.14	321.68	2.41	543.71	537.82	26
6 24	28.80	31	503.75	825.43	2.20	544.48	540.74	146
6 25	46.70	129	826.44	1651.87	2.75	537.37	538.58	129
6 26	77.90	51	344.54	1996.41	2.77	549.76	540.55	149
6 27	68.70	89	413.92	2410.34	2.72	543.40	541.05	178
6 28	67.60	89	1028.79	3439.12	2.65	544.33	542.04	248
6 29	29.20	75	2272.51	5711.64	2.67	545.21	543.31	400
6 30	29.40	106	2974.10	8685.74	2.65	542.73	543.11	611
7 1	30.70	84	1007.34	9693.08	2.61	544.22	543.23	683
7 2	49.00	115	2086.14	11779.22	2.62	535.54	541.86	857 [2]
7 3	62.90	107	598.77	12377.99	2.24	520.01	540.80	923
7 4	36.70	126	1384.83	13762.82	2.45	530.82	539.79	1,050
7 5	48.90	152	1596.08	15358.89	2.45	544.23	540.26	1,154
7 6	18.00	127	3318.55	18677.44	2.66	551.30	542.22	1,345
7 7	30.50	129	1707.50	20384.94	2.71	544.03	542.37	1,462
7 8	15.50	183	3342.64	23727.58	2.62	548.89	543.29	1,708
7 9	6.70	75	2689.53	26417.11	2.64	540.52	543.14	1,861
7 10	81.90	66	301.39	26718.51	2.40	531.08	543.00	1,889
7 11	92.00	45	130.63	26849.13	2.32	517.02	542.87	1,906
7 12	87.20	35	98.08	26947.22	2.12	510.36	542.74	1,913
TOTAL		1912	26947.22					
MEAN					2.60	542.74		

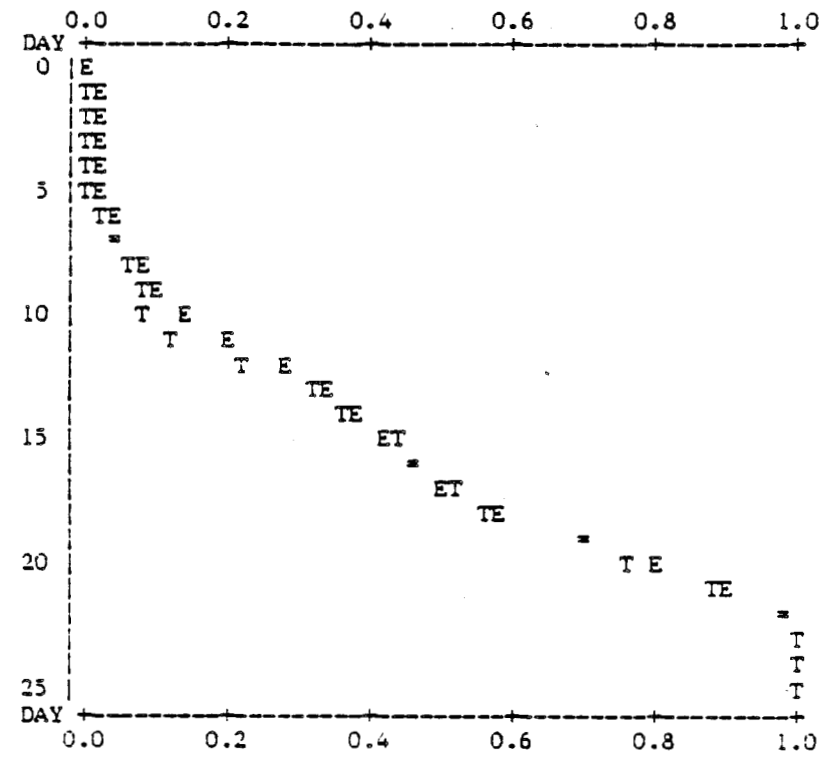
[1] $Y = (3.1678 \times 10^{30}) \times [-10.5407]$, where Y = EPI, X = mean length (mm), and $R^2 = 0.7383$.

[2] Escapement estimates based upon running mean length until 2 July. Estimates for 2 July based upon aerial survey, estimates from 3 July until end of season based upon lag time analysis (Table 4).

EGEGIK

7/12 ACCUMULATED ESCAPEMENT = 1,117,710
7/12 ACCUMULATED INDEX= 26947.21875 (4 SETS ON LAST DAY)
MEAN LENGTH = 542.74 FISH/INDEX = 70 FORECAST = 1,912,960 (POWER CURVE)
MEAN WEIGHT =2.60 KG (5.73 LBS)

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/12
1	41.629	1,121,793	492226.84	1117710.00
2	41.833	1,127,277	234753.45	1117710.00
3	42.310	1,140,138	161756.33	1117710.00
4	47.106	1,269,374	279309.09	1117710.00
5	54.830	1,477,520	369153.72	1117710.00



INDEX	FORECAST	ACTUAL
0.00	0.00	7074.00
116.14	4913.98	17556.00
128.98	5457.19	19896.00
170.47	7212.60	25734.00
206.94	8755.79	26670.00
236.54	10008.16	29724.00
321.68	13610.31	34506.00
825.43	34924.10	54036.00
1651.87	69890.87	84222.00
1996.41	84468.44	121776.00
2410.34	101981.46	168420.00
3439.12	145509.47	234624.00
5711.64	241659.73	320490.00
8685.74	367494.19	389184.00
9693.08	410114.94	428826.00
11779.22	498379.62	470814.00
12377.99	523713.72	513846.00
13762.82	582305.81	568452.00
15358.89	649835.94	656982.00
18677.44	790243.81	789744.00
20384.94	862488.44	902994.00
23727.58	1003915.56	1018530.00
26417.11	1117710.00	1117710.00
26718.51	1130462.00	0.00
26849.13	1135988.87	0.00
26947.22	1140138.87	0.00

INDEX FORECAST ACTUAL

TIME LAG = 3

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	25
ESCAPEMENT	E	24

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 4. Computer printout showing estimate of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimate of lag time by cumulative escapement divided by cumulative index method; plot of cumulative index and escapement curves on last day of test fishing, Egegik River, 1984.

Table 4. Sockeye salmon spawning escapement estimated during the season based upon lag time analysis of test fishing data, Egegik River, 1984.

WITHIN SEASON FORECAST			ACTUAL ESCAPEMENT		
DATE	LAG (DAYS)	ESCAPEMENT (THOUSANDS)	DATE PLUS LAG	CUMULATIVE TOWER COUNT (THOUSANDS)	PERCENT ERROR OF FORECAST
6 24	3	1965231[1]	6 27	54,036	264
6 25	3	207,754[2]	6 28	84,222	147
6 26	4	291,229[2]	6 30	168,420	73
6 27	4	404,889[2]	7 1	234,624	73
6 28	3	175,346	7 1	234,624	-25
6 29	3	348,394[2]	7 2	320,490	9
6 30	1 OR 4	505,280[2]	7 4	428,826	18
7 1	2	398,174	7 3	389,184	2
7 2	3	660,890[3]	7 5	470,814	40
7 3	3[4]	554,546	7 6	513,846	8
7 4	3[4]	608,796	7 7	568,452	7
7 5	2	584,129	7 7	568,452	3
7 6	2	697,264	7 8	656,982	6
7 7	2	754,281	7 9	789,744	-4
7 8	2	836,455	7 10	902,994	-7
7 9	2[4]	1,023,369	7 11	1,018,530	<1
7 10	2[4]	1,016,758	7 12	1,117,710	-9
7 11	2	1,035,579	7 13	1,139,046	-9
7 12	3	1,134,312[3]	7 15	1,151,028	-1

[1] Lag time estimate averaged with power curve estimate to calculate escapement estimate used during season.

[2] Escapement estimate based upon lag time analysis not used during season.

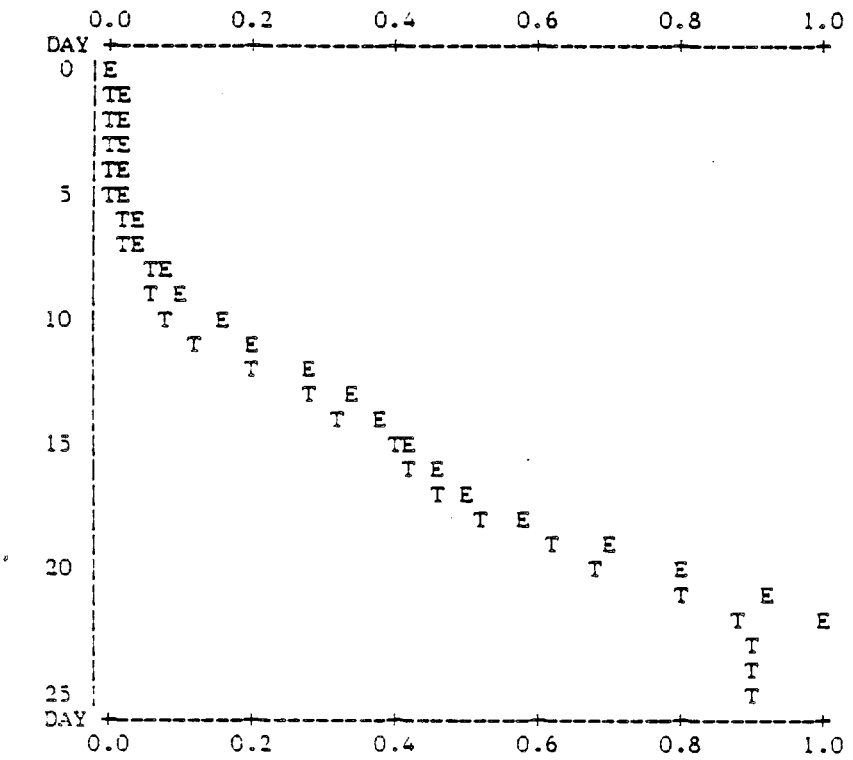
[3] Aerial survey estimate used during season instead of lag time estimate.

[4] Lag time chosen for estimate did not minimize sum of errors squared, but was considered to be the most reasonable choice.

EGEGIK

7/12 ACCUMULATED ESCAPEMENT = 1,117,710
7/12 ACCUMULATED INDEX= 26947.21875 (4 SETS ON LAST DAY)
MEAN LENGTH = 542.74 FISH/INDEX = 70 FORECAST = 1,912,960 (POWER CURVE)
MEAN WEIGHT =2.60 KG (5.73 LBS)

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/12
1	31.827	857,642	2348781.75	854320.94
2	35.004	943,253	434018.53	935248.12
3	37.279	1,004,571	463430.47	984809.37
4	36.004	970,220	616612.56	854299.25
5	37.915	1,021,712	908305.25	772901.62



INDEX	FORECAST	ACTUAL
0.00	0.00	7074.00
116.14	4329.69	17556.00
128.98	4808.30	19896.00
170.47	6354.99	25734.00
206.94	7714.68	26670.00
236.54	8818.15	29724.00
321.68	11991.99	34506.00
825.43	30771.47	54036.00
1651.87	61580.54	84222.00
1996.41	74424.77	121776.00
2410.34	89855.41	168420.00
3439.12	128207.75	234624.00
5711.64	212925.33	320490.00
8685.74	323797.53	389184.00
9693.08	361350.47	428826.00
11779.22	439120.09	470814.00
12377.99	461441.87	513846.00
13762.82	513067.09	568432.00
15358.89	572567.62	656982.00
18677.44	696280.37	789744.00
20384.94	759934.81	902994.00
23727.58	884545.62	1018530.00
26417.11	984809.37	1117710.00
26718.51	996045.06	0.00
26849.13	1000914.81	0.00
26947.22	1004571.31	0.00

TIME LAG = 3

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	25
ESCAPEMENT	E	24

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 5. Computer printout showing estimate of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimate of lag time by least squares method; plot of cumulative index and escapement curves on last day of test fishing, Egegik River, 1984.

Ugashik River

Test fishing began on 24 June and ended on 17 July. A total of 793 sockeye salmon were caught resulting in 20,137.66 cumulative index points (Appendix Table 9). Sockeye salmon mean length and weight were 522.86 mm and 2.23 kg, respectively (Table 5 and Appendix Table 10).

Neither a power curve model (equation 1.1) based upon running mean length nor lag time analysis was relied upon during the season to forecast escapements, since most sockeye salmon escaping the fishery remained within the river mouth and lagoon and did not begin moving past the test fishing site in substantial numbers until 11 July. Therefore, cumulative test fish indices, as well as tower counts, greatly underestimated the number of sockeye salmon actually within the river. Aerial surveys were used to directly forecast escapement and to select lag times to forecast escapements.

At the end of the season, 17 July, the length model produced an escapement forecast of 697,803, 20% less than the cumulative tower count on that day (Figure 6). Results of lag time analysis indicated that one, seven, and eight-day lag times all performed equally well in minimizing the squared sums of errors between escapement estimates and tower counts (equation 2.1). A one-day lag time produced an escapement forecast of 1,003,970 for 18 July, only 1% greater than the cumulative tower count for that day, while seven and eight-day lag times produced forecasts which were 8.7 and 9.6 times greater, respectively, than corresponding tower counts seven and eight days later. Daily percent errors of lag time forecasts used during the season ranged from 585 to -87 (Table 6).

The least squares method of calculating lag time (equation 2.2) did not produce a more accurate forecast after the season than that produced by the method used during the season (Figure 7). An eight-day lag time had the smallest sums of errors squared, but produced a forecast which was 8.3 times greater than the corresponding cumulative tower count eight days later. A five-day lag time would have produced the best forecast for this method, but this lag time had one of the highest sums of errors squared.

Igushik River

Test fishing was conducted from 18 June until 14 July. A total of 1,206 sockeye salmon were caught resulting in 25,742.54 cumulative daily index points, including interpolated data (Appendix Table 11). Sockeye salmon mean length and weight were 570.34 mm and 3.18 kg, respectively (Table 7).

Due to problems with interpretation of test fishing data, results of this project were used as qualitative, rather than quantitative, measures of sockeye salmon spawner abundance during the season.

Attempts were made to use a linear regression model (equation 1.2) based upon running mean weight to forecast escapements during the early portion of the season. However, weight model forecasts tended to be much greater than aerial survey estimates and cumulative tower counts. Therefore, escapement estimates from this model were not used during most of the season.

Table 5. Sockeye salmon escapement test fishing data, including daily estimates of spawning escapement made during the season based upon running mean length, Ugashik River, 1984.

DATE	FISHING TIME	CATCH	INDEX	CUMULATIVE INDEX	MEAN WEIGHT	MEAN LENGTH	RUNNING MEAN LENGTH	ESTIMATED CUMULATIVE ESCAPEMENT (THOUSANDS) FROM POWER CURVE [1]
6 24	88.33	3	7.42	7.42	3.86	505.61	505.61	1 [2]
6 25	102.28	5	12.13	19.56	2.24	516.43	510.92	1
6 26	79.99	1	3.41	22.96	2.46	540.00	516.43	1
6 27	93.68	4	11.19	34.15	2.53	558.47	532.55	1
6 28	86.62	3	9.04	43.19	2.34	537.25	533.66	1
6 29	93.22	20	61.53	104.73	2.31	531.31	532.21	3
6 30	97.64	15	38.71	143.43	2.49	536.18	533.32	5
7 1	98.83	10	25.77	169.20	2.44	540.50	534.45	5
7 2	90.68	12	32.98	202.19	2.54	543.08	535.89	6
7 3	40.80	9	51.46	253.65	2.46	534.59	535.74	7
7 4	67.58	12	43.04	296.69	2.17	522.40	533.58	9
7 5	78.00	27	82.55	379.24	2.27	528.56	532.39	12
7 6	68.88	54	198.39	577.63	2.23	524.13	529.39	18
7 7	44.29	57	361.28	938.90	2.27	522.18	526.53	31
7 8	47.37	53	275.78	1214.69	2.04	511.96	523.13	42
7 9	62.57	73	277.40	1492.09	2.24	524.64	523.42	51
7 10	60.73	38	175.80	1667.89	2.16	522.40	523.31	57
7 11	26.96	49	2300.82	3968.71	2.13	511.00	517.29	151
7 12	12.02	37	2957.99	6926.70	2.12	512.05	515.64	263
7 13	8.62	102	6112.64	13039.34	2.45	532.74	525.32	476
7 14	52.81	55	649.89	13689.24	2.54	531.96	525.70	474
7 15	30.18	21	175.27	13864.51	2.33	529.37	525.73	463
7 16	24.10	85	3650.72	17515.22	2.03	514.99	523.15	605
7 17	22.89	48	2622.43	20137.66	2.16	521.22	522.86	—
TOTAL		793	20137.66					
MEAN					2.23	522.86		

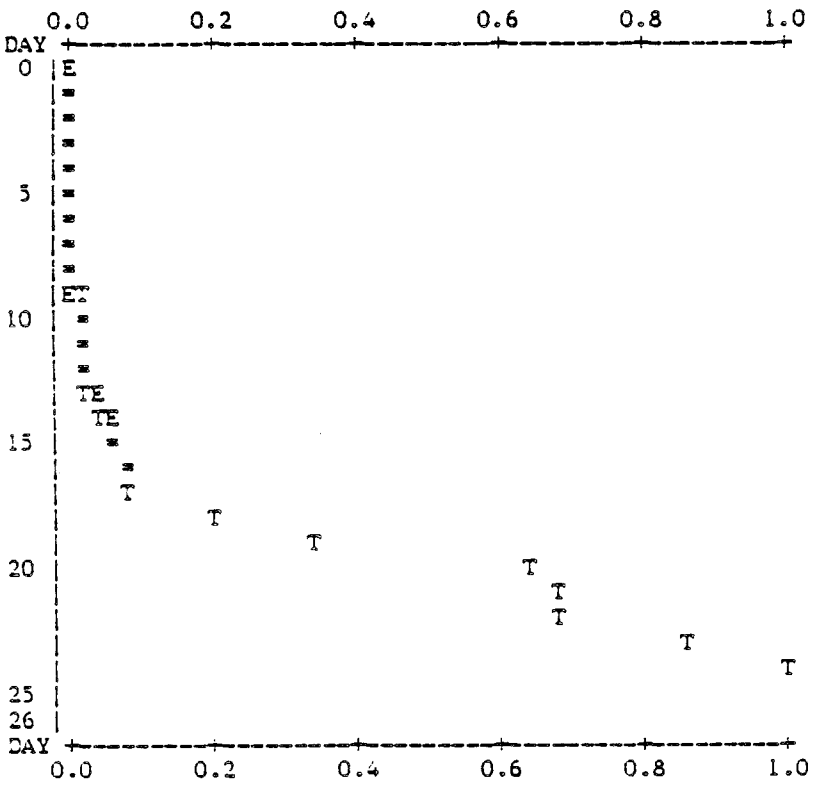
[1] $Y = (9.4190 \times 10^{21}) \times [-7.4932]$, where Y = EPI, X = mean length (mm), and $R^2 = 0.5516$.

[2] Escapement estimates based upon aerial surveys most of the season, rather than test fishing data, since sockeye salmon stayed within lagoon below test fishing site and did not begin to move past the counting tower until 11 July.

UGASHIK

7/17 ACCUMULATED ESCAPEMENT = 873,228
7/17 ACCUMULATED INDEX= 20137.65820 (4 SETS ON LAST DAY)
MEAN LENGTH = 522.86 FISH/INDEX = 34 FORECAST = 697,803 (POWER CURVE)
MEAN WEIGHT =2.25 KG (4.95 LBS)

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/17
1	49.855	1,003,970	250868.52	873228.00
2	62.983	1,268,329	361900.47	873228.00
3	63.789	1,284,568	412109.78	873228.00
4	66.969	1,348,593	580025.44	873228.00
5	126.067	2,538,693	537309.69	873228.00
6	220.028	4,430,857	467199.75	873228.00
7	523.553	10,543,136	245672.16	873228.06
8	585.238	11,785,321	245386.97	873228.00
9	718.891	14,476,788	325468.22	873228.00



INDEX	FORECAST	ACTUAL
0.00	0.00	7014.00
7.42	4344.88	9720.00
19.56	11446.32	9792.00
22.96	13439.19	9792.00
34.15	19988.63	9816.00
43.19	25277.75	9816.00
104.73	61289.54	9834.00
143.43	83941.23	9834.00
169.20	99024.24	9858.00
202.19	118326.96	10008.00
253.65	148443.47	155178.00
296.69	173631.67	235794.00
379.24	221944.08	299634.00
577.63	338048.59	460926.00
938.90	549482.00	596286.00
1214.69	710880.87	641820.00
1492.09	873228.00	873228.00
1667.89	976111.19	0.00
3968.71	2322636.75	0.00
6926.70	4053767.25	0.00
13039.34	7631117.00	0.00
13689.24	8011460.00	0.00
13864.51	8114035.50	0.00
17515.22	10250574.00	0.00
20137.66	11785321.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00

INDEX	FORECAST	ACTUAL

TIME LAG = 8

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	24
ESCAPEMENT	E	26

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 6. Computer printout showing estimate of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimate of lag time by cumulative escapement divided by cumulative index method; plot of cumulative index and escapement curves on last day of test fishing, Ugashik River, 1984.

Table 6. Sockeye salmon spawning escapement estimated during the season based upon lag time analysis of test fishing data, Ugashik River, 1984.

WITHIN SEASON FORECAST			ACTUAL ESCAPEMENT		
DATE	LAG (DAYS)	ESCAPEMENT (THOUSANDS)	DATE PLUS LAG	CUMULATIVE TOWER COUNT (THOUSANDS)	PERCENT ERROR OF FORECAST
6 26	2	937[1]	6 28	480	95
6 27	3	2,020[1]	6 30	2,664	-24
6 28	1 - 4	1,500[1]	7 2	9,720	-85
6 29	4	4,851	7 3	9,792	-50
6 30	5	20,419[1]	7 5	9,816	108
7 1	3	27,476[2]	7 4	9,792	181
7 2	5	57,539	7 7	9,834	585
7 3	5	57,503	7 8	9,834	485
7 4	6	67,260	7 10	10,008	572
7 5	7	86,186[2]	7 12	235,794	-63
7 6	7 OR 8	92,707[2]	7 14	460,926	-80
7 7	8	88,165[3]	7 15	596,286	-85
7 8	9	111,777[4]	7 17	873,228	-87
7 9	NO WAY TO CHOOSE AMONG LAG TIMES				
7 10	NO WAY TO CHOOSE AMONG LAG TIMES				
7 11	4	655,972	7 15	596,286	10
7 12	5	1,761,687[1]	7 17	873,228	102
7 13	5	3,248 695[1]	7 18	995,928	226
7 14	2	949,064	7 16	641,820	48
7 15	NO WAY TO CHOOSE AMONG LAG TIMES				
7 16	3	866,177	7 19	1,087,284	-20
7 17	NO ESTIMATE MADE DURING SEASON				

[1] Escapement estimate based upon lag time analysis not used during season.

[2] Lag time chosen for estimate did not minimize sum of errors squared, but was considered to be the most reasonable choice.

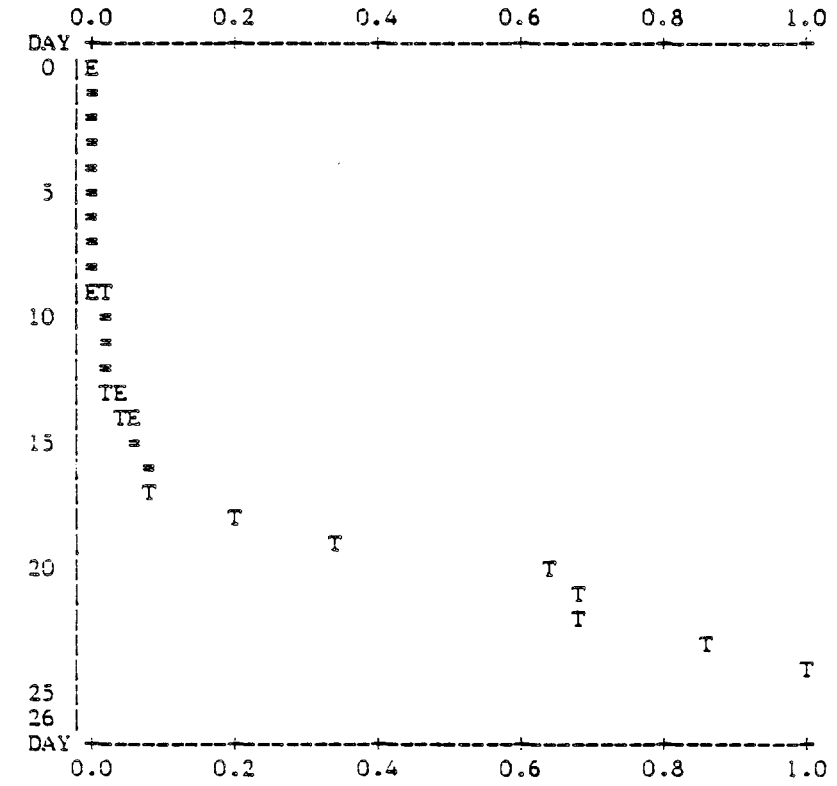
[3] Lag time estimate averaged with manager's assessment to calculate escapement estimate used during season.

[4] Aerial survey estimate used during season instead of lag time estimate.

UGASHIK

7/17 ACCUMULATED ESCAPEMENT = 873,228
7/17 ACCUMULATED INDEX= 20137.65820 (4 SETS ON LAST DAY)
MEAN LENGTH = 522.86 FISH/INDEX = 34 FORECAST = 697,803 (POWER CURVE)
MEAN WEIGHT =2.25 KG (4.95 LBS)

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/17
1	35.492	714,734	1383060.62	621657.50
2	30.181	607,765	549859.94	418438.69
3	24.407	491,508	807949.00	334118.78
4	38.267	770,617	1042627.12	498982.94
5	64.749	1,303,891	1085590.62	448496.16
6	118.876	2,393,884	1083689.87	471783.87
7	468.524	9,434,983	1050030.00	781446.06
8	508.954	10,249,148	372635.87	759405.94
9	499.143	10,051,566	550633.81	606302.25



DAY	INDEX	FORECAST	ACTUAL
0	0.00	0.00	7014.00
	7.42	3778.34	9720.00
	19.56	9954.34	9792.00
	22.96	11687.44	9792.00
	34.15	17383.18	9816.00
5	43.19	21982.89	9816.00
	104.73	53300.68	9834.00
	143.43	72999.80	9834.00
	169.20	86116.80	9858.00
	202.19	102903.48	10008.00
10	253.65	129094.41	155178.00
	296.69	150999.42	235794.00
	379.24	193014.50	299634.00
	577.63	293985.19	460926.00
	938.90	477859.06	596286.00
15	1214.69	618220.19	641820.00
	1492.09	759405.94	873228.00
	1667.89	848878.69	0.00
	3968.71	2019889.62	0.00
	6926.70	3525373.75	0.00
20	13039.34	6636429.50	0.00
	13689.24	6967196.00	0.00
	13864.51	7056401.00	0.00
	17515.22	8914449.00	0.00
	20137.66	10249148.00	0.00
25	0.00	0.00	0.00
26	0.00	0.00	0.00
DAY	INDEX	FORECAST	ACTUAL

TIME LAG = 8

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	24
ESCAPEMENT	E	26

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 7. Computer printout showing estimate of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimate of lag time by least squares method; plot of cumulative index and escapement curves on last day of test fishing, Ugashik River, 1984.

Table 7. Sockeye salmon escapement test fishing data, including daily estimates of spawning escapement made during the season based upon running mean weight, Igushik River, 1984.

DATE	FISHING TIME	CATCH	INDEX	CUMULATIVE INDEX	MEAN WEIGHT	MEAN LENGTH	RUNNING MEAN WEIGHT	ESTIMATED CUMULATIVE ESCAPEMENT (THOUSANDS) FROM LINEAR REG.[1]
6 18	51.30	8	36.37	36.37	3.10	564.57	3.10	1[2]
6 19	53.00	11	53.74	90.11	2.92	557.12	3.00	4
6 20	41.00	26	194.91	285.02	3.16	575.85	3.09	11
6 21	46.00	31	181.02	466.04	3.17	565.75	3.12	18
6 22	42.50	52	524.31	990.35	3.29	566.18	3.19	34
6 23	25.00	62	663.33	1653.68	3.09	558.65	3.16	60
6 24	5.00	19	912.00	2565.68	3.10	568.00	3.15	94
6 25	15.00	67	1107.86	3673.54	3.20	572.97	3.16	133
6 26	14.00	91	1506.00	5179.54	3.01	568.88	3.13	196
6 27	15.50	36	903.91	6083.45	3.18	568.96	3.13	230
6 28	21.00	18	205.71	6289.16	2.90	564.00	3.12	241
6 29	22.50	29	360.00	6649.16	3.09	563.62	3.12	255
6 30	25.50	64	1277.33	7926.50	3.72	591.22	3.19	276
7 1	9.50	65	1610.67	9537.16	3.06	565.72	3.18	336
7 2	11.50	75	1609.52	11146.69	3.23	570.30	3.18	393
7 3	8.50	40	1176.00	12322.69	3.08	570.88	3.18	435
7 4	9.50	37	938.67	13261.35	3.12	565.86	3.18	468
7 5	10.00	58	1347.88	14609.23	3.07	568.01	3.17	523
7 6	13.50	46	1243.64	15852.87	3.12	565.37	3.17	567
7 7	13.50	50	895.38	16748.25	3.16	575.80	3.16	608
7 8	5.00	19	912.00	17660.25	3.20	570.00	3.17[3]	632
7 9	5.00	19	912.00	18572.25	3.20	570.00	3.17[3]	665
7 10	14.50	76	1267.06	19839.31	3.10	567.19	3.17	710
7 11	11.50	70	1554.00	21393.31	3.26	573.20	3.17	765
7 12	8.50	67	1906.29	23299.60	3.20	571.52	3.17	834
7 13	6.50	55	2064.00	25363.60	3.25	572.53	3.17	908
7 14	9.50	15	378.95	25742.54	2.90	559.00	3.17	921
TOTAL		1206	25742.54					
MEAN					3.17	570.34		

[1] $Y = 195.9302 - 50.5202 X$, where Y = EPI, X = mean weight (kg), and $R^2 = 0.6002$.
[2] Escapement estimates based upon mean weight not used during season.
[3] Interpolated data.

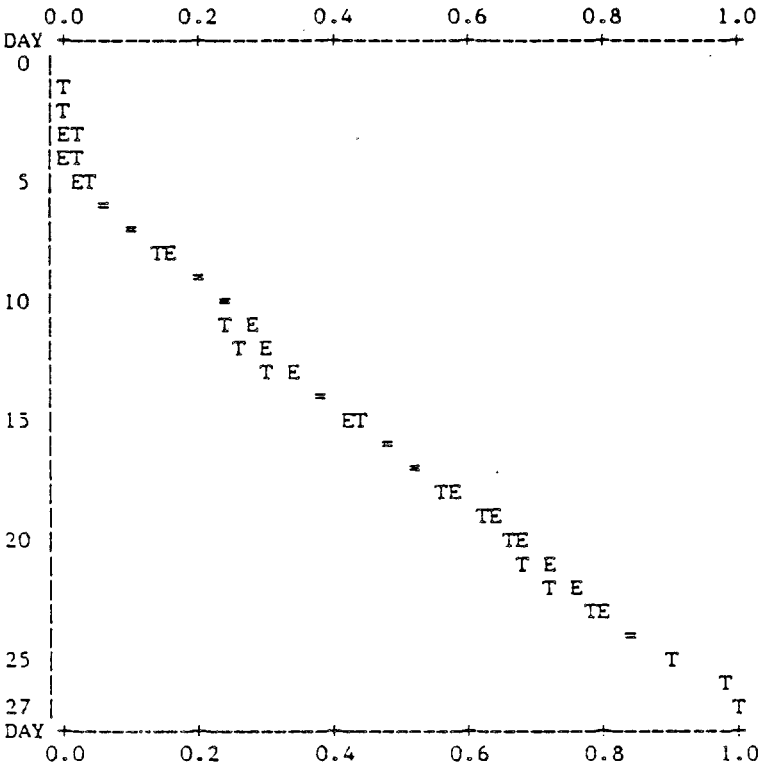
At the end of the season, 14 July, the length model produced an escapement forecast of 908,097, which was 6.3 times greater than the cumulative tower count for that day and 4.9 times greater than the cumulative tower count for the entire season (Figure 8).

Lag time analysis was not used during the season due to problems with the computer software at the Dillingham ADF&G office. At the end of the season a three-day lag time minimized the squared sums of errors between escapement estimates and tower counts (equation 2.1) (Figure 8). This lag time produced an escapement forecast of 172,834 for 17 July, only 6% less than the cumulative tower count of 162,054 for that day.

IGUSHIK

7/14 ACCUMULATED ESCAPEMENT = 143,634
7/14 ACCUMULATED INDEX= 25742.54492 (1 SETS ON LAST DAY)
MEAN WEIGHT =3.18 KG (6.99 LBS)
FISH/INDEX =35.4 FORECAST = 910,731

LAGTIME	FISH PER INDEX	FORECAST AHEAD	SUMS OF SQUARES	FORECAST 7/14
1	5.663	145,779	34045.59	143634.00
2	6.165	158,693	24192.77	143634.00
3	6.714	172,834	17192.38	143634.00
4	7.240	186,372	23486.42	143634.00
5	7.734	199,087	38940.26	143634.00
6	8.133	209,368	58887.33	143634.00
7	8.576	220,769	79178.01	143634.00
8	9.060	233,238	99469.96	143634.00
9	9.832	253,093	115378.60	143634.00
10	10.831	278,818	129070.90	143634.00
11	11.656	300,056	145733.37	143634.00
12	12.886	331,713	158419.98	143634.00
13	15.060	387,694	163807.89	143634.00
14	18.121	466,474	168007.59	143634.00
15	21.602	556,085	176680.02	143634.00



INDEX	FORECAST	ACTUAL
0.00	0.00	0.00
36.37	244.21	0.00
90.11	605.01	0.00
285.02	1913.63	6.00
466.04	3128.96	264.00
990.35	6649.15	2754.00
1653.68	11102.75	10110.00
2565.68	17225.88	17262.00
3673.54	24664.00	26778.00
5179.54	34775.24	34134.00
6083.45	40844.08	42120.00
6289.16	42225.24	47238.00
6649.16	44642.27	53220.00
7926.50	53218.24	59280.00
9537.16	64032.21	65718.00
11146.69	74838.49	73458.00
12322.69	82734.12	83418.00
13261.35	89036.30	91548.00
14609.23	98085.91	101322.00
15852.87	106435.65	110406.00
16748.25	112447.23	117156.00
17660.25	118570.37	123642.00
18572.25	124693.51	130014.00
19839.31	133200.50	136614.00
21393.31	143634.00	143634.00
23299.60	156432.73	0.00
25363.60	170290.36	0.00
25742.54	172834.61	0.00
INDEX	FORECAST	ACTUAL

TIME LAG = 3

CURVE	DATA POINT PLOT SYMBOL	NUMBER OF POINTS
TEST FISH	T	27
ESCAPEMENT	E	22

THE PLOT SYMBOL = USED WHEN 2 DATA POINTS ARE IN SAME PLOT POSITION

Figure 8. Computer printout showing estimates of EPI and forecast of escapement from running mean length by linear and power curve regressions; estimates of lag time by cumulative escapement divided by cumulative index method; plot of cumulative index and escapement curves on last day of test fishing, Igushik River, 1984.

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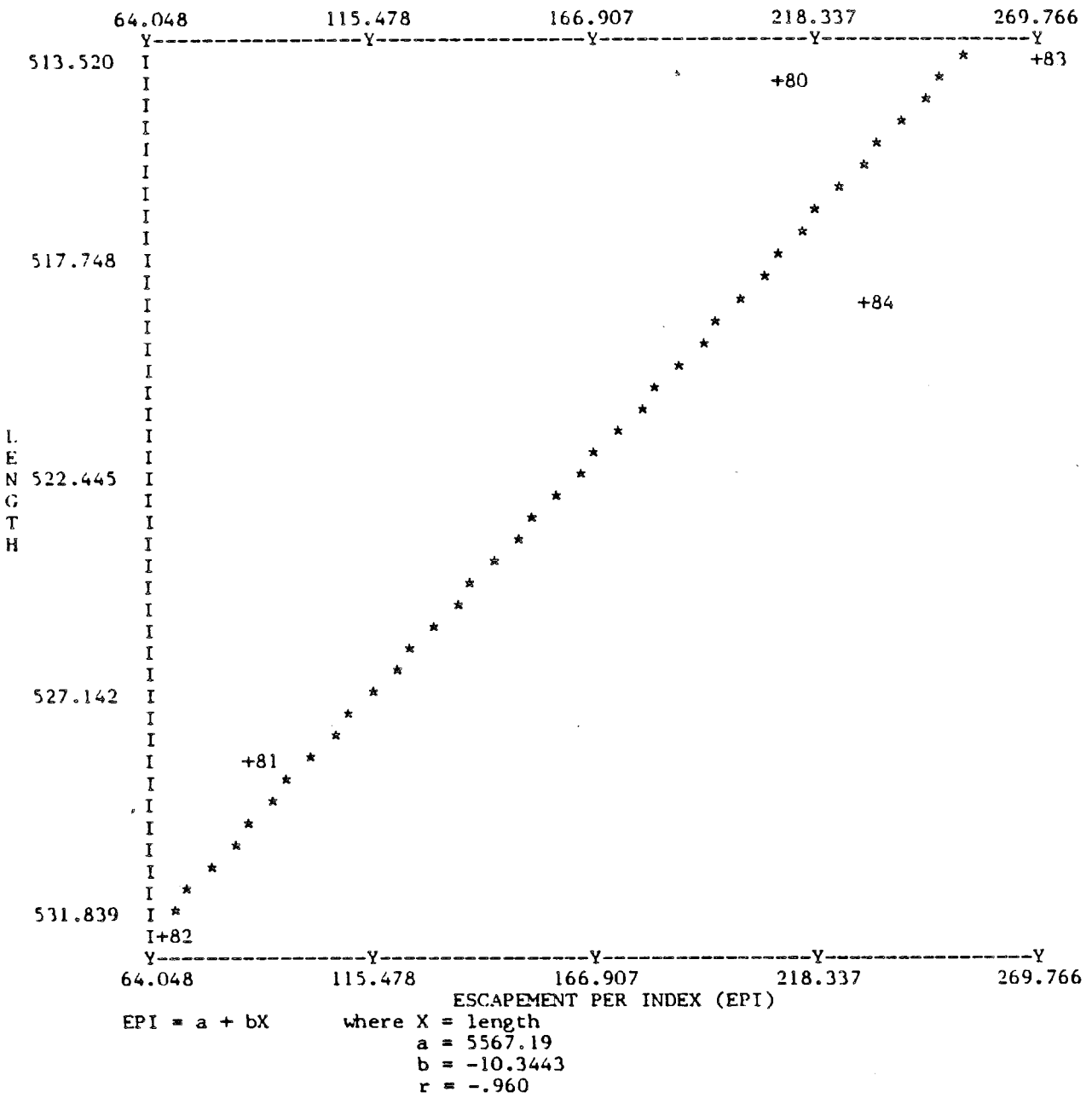
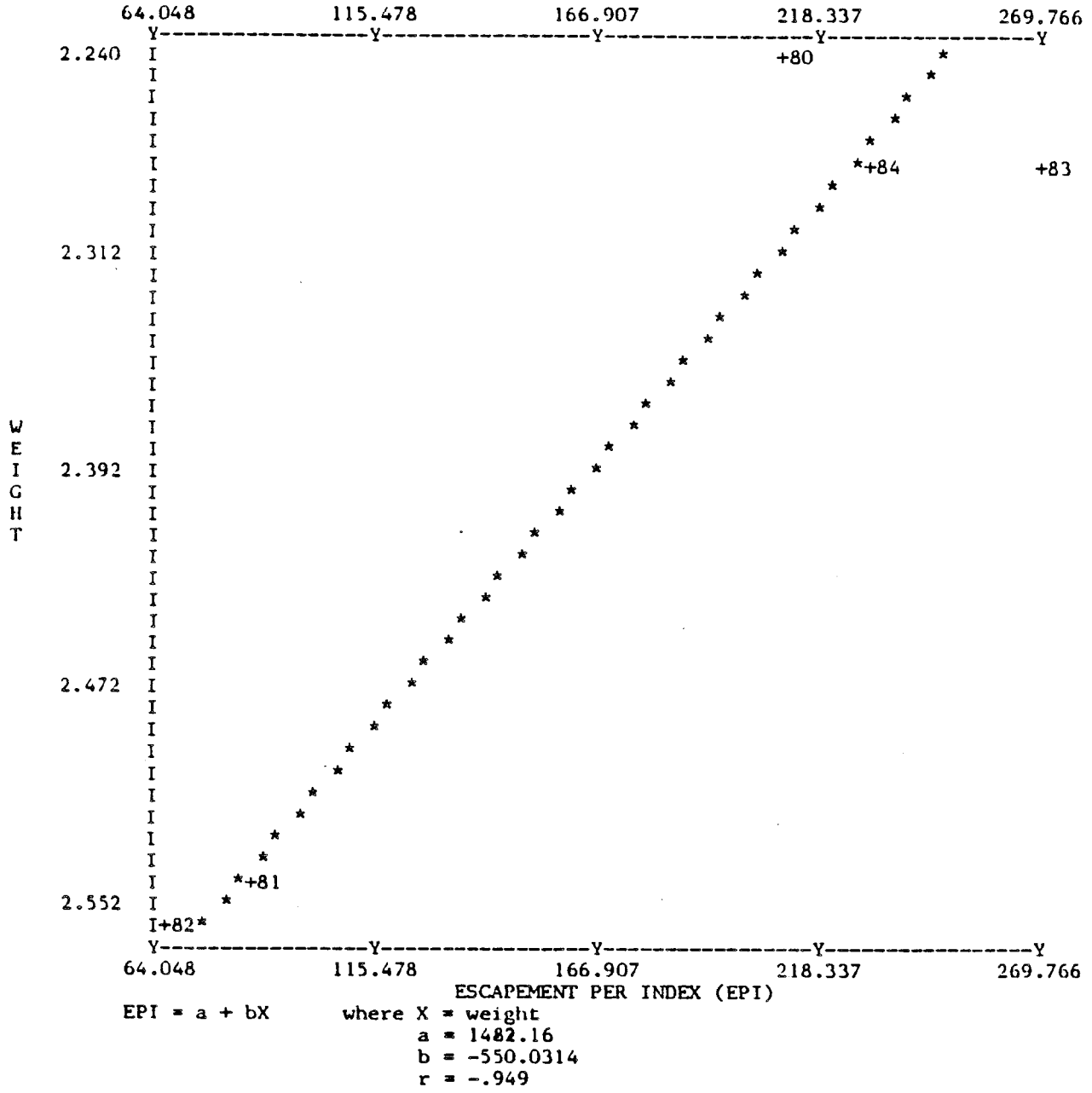
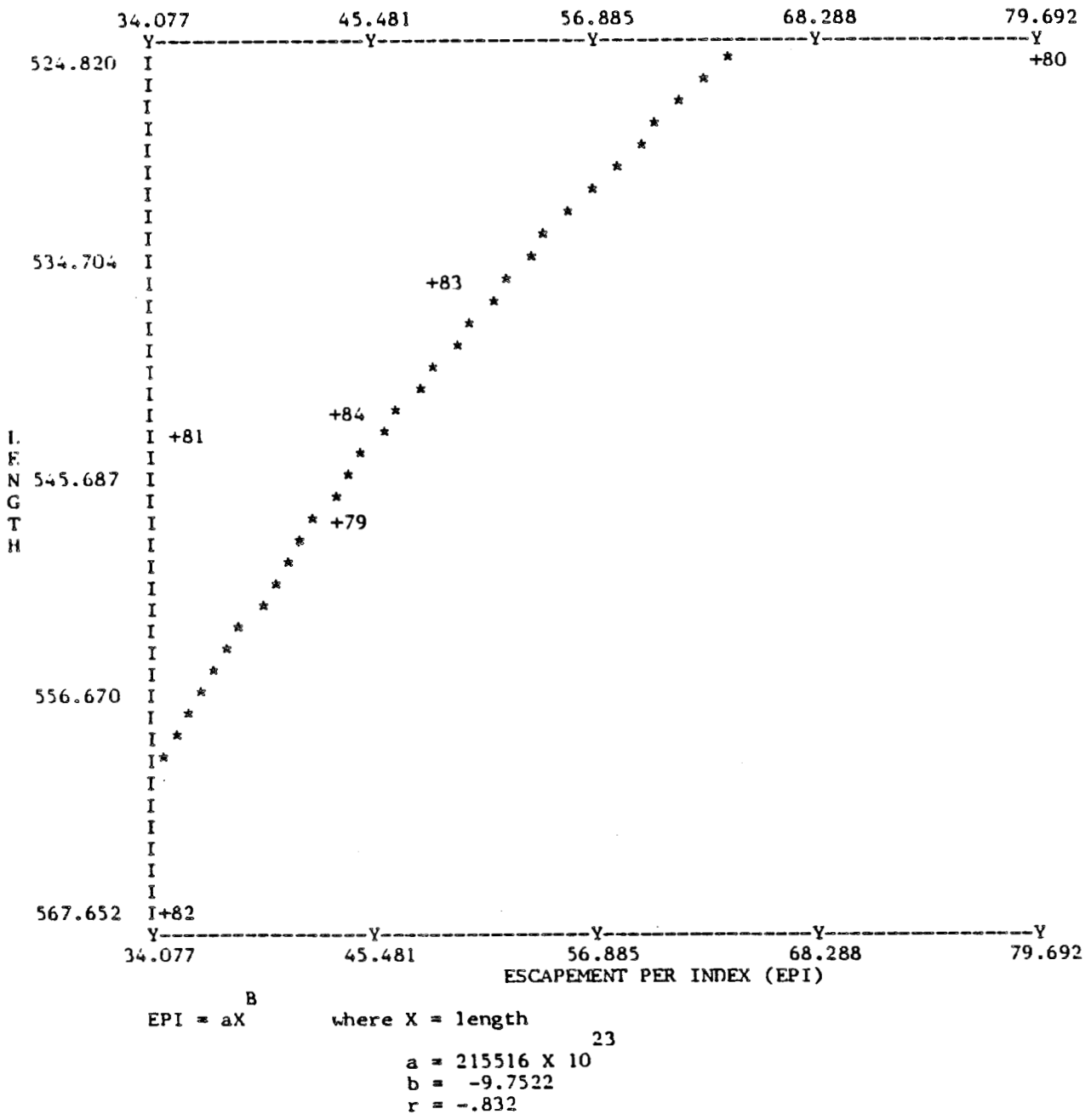
APPENDIX



Appendix Figure 1. Linear regression of Kvichak test fish EPI values on mean lengths in Appendix Table 1.



Appendix Figure 2. Linear regression of Kvichak test fish EPI values on mean weights in Appendix Table 1.



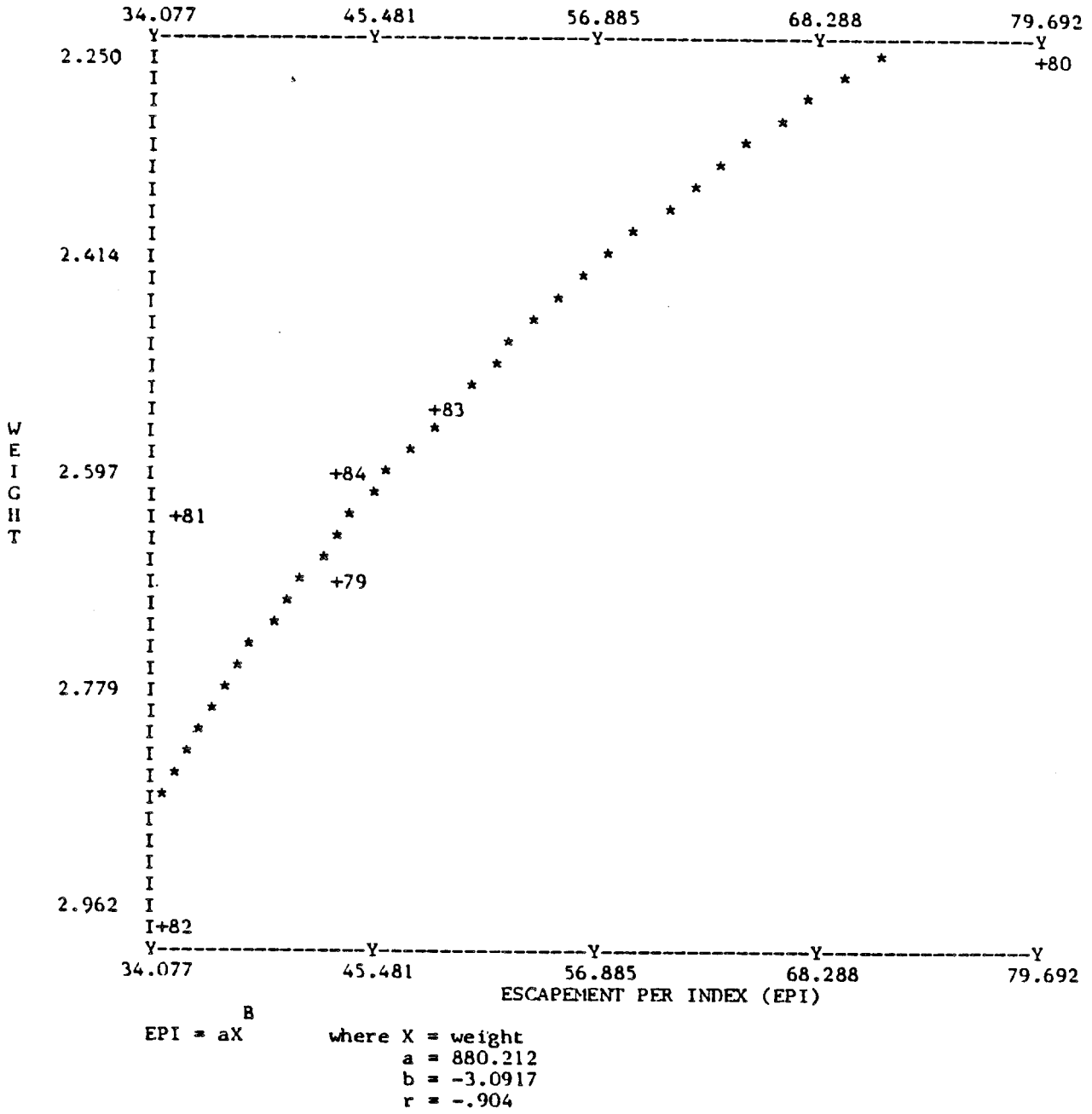
$EPI = aX^{B}$ where X = length

$a = 215516 \times 10^{23}$

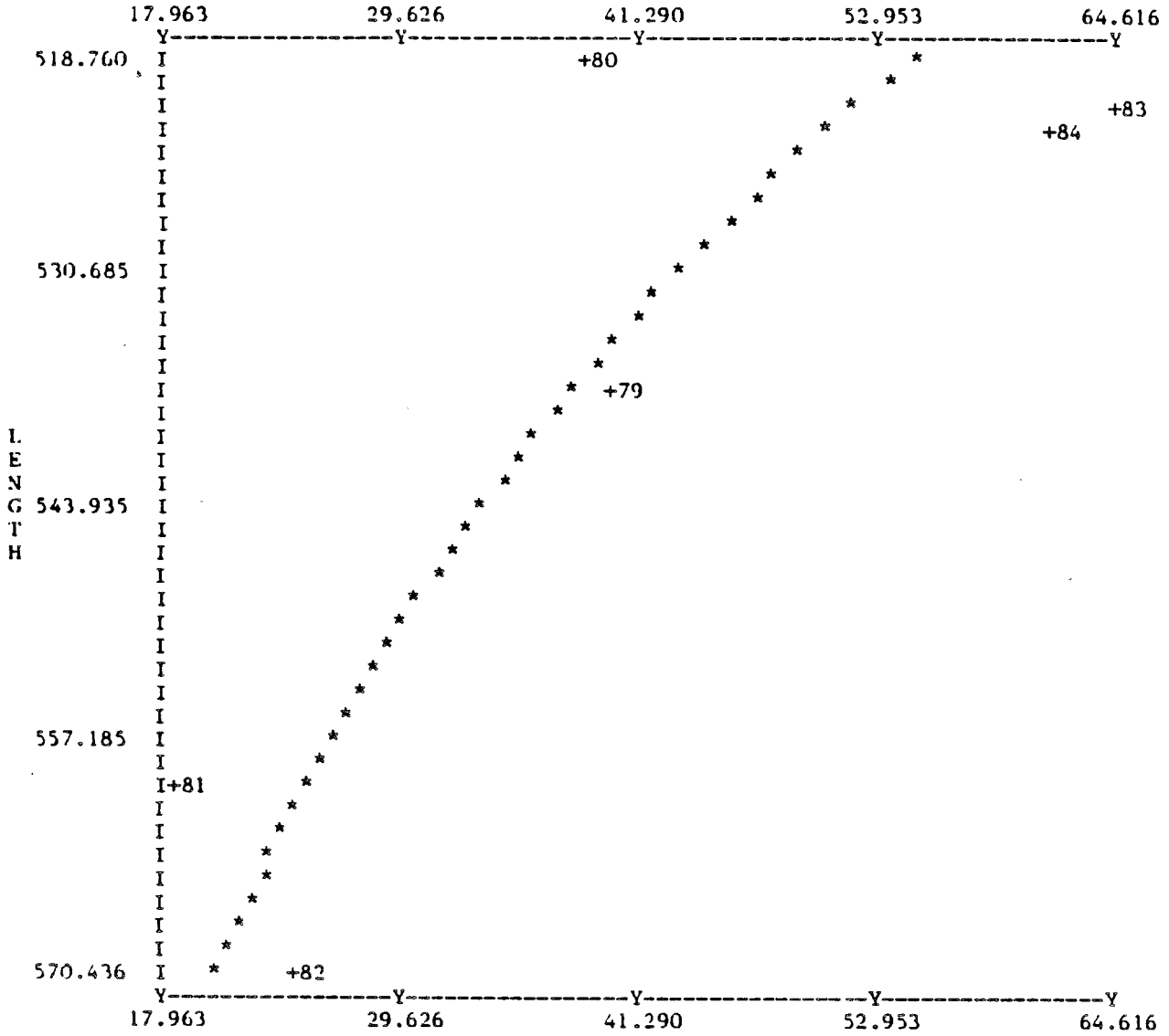
$b = -9.7522$

$r = -.832$

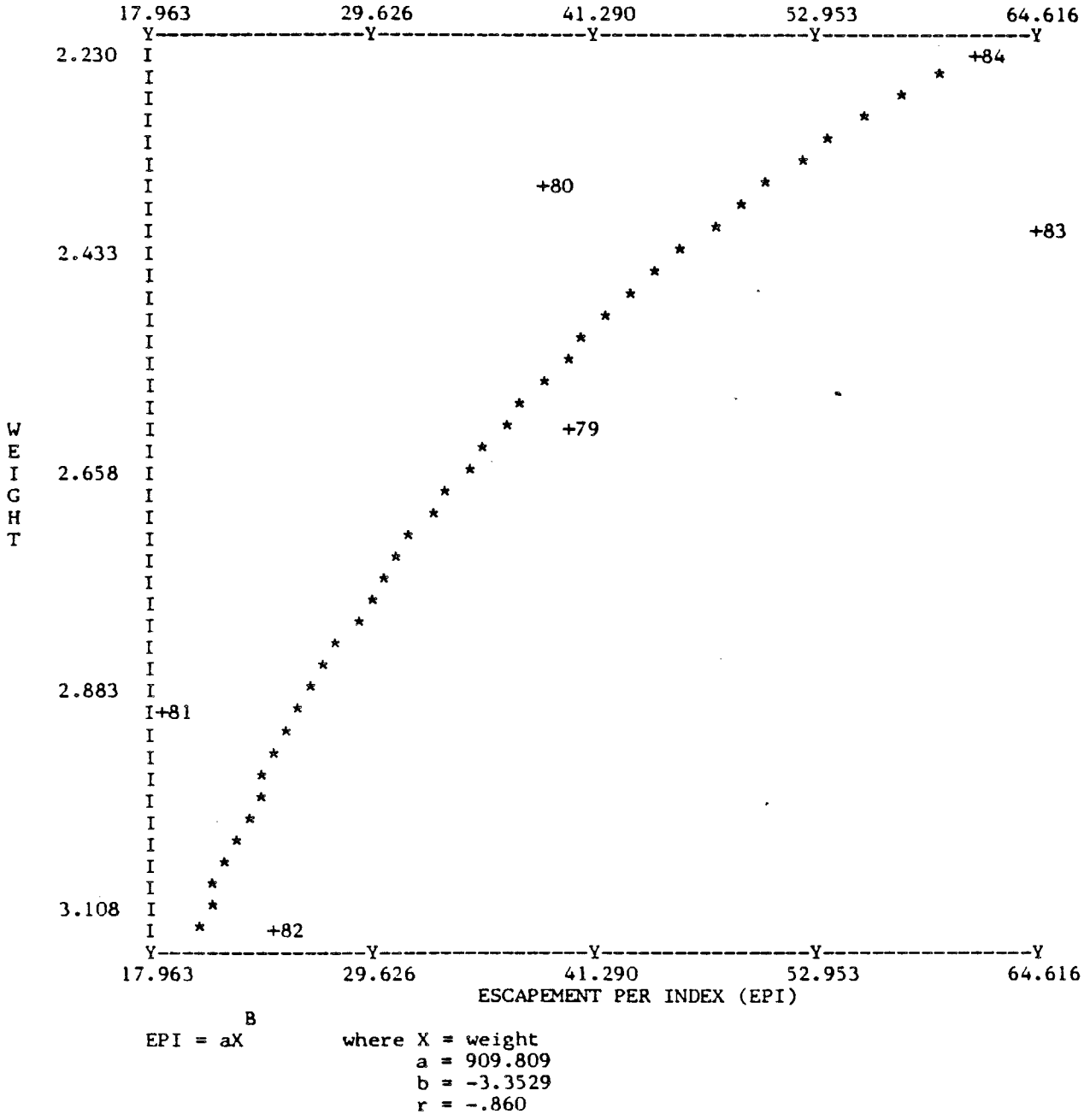
Appendix Figure 3. Power curve fit of Egegik test fish EPI values and mean lengths in Appendix Table 2.



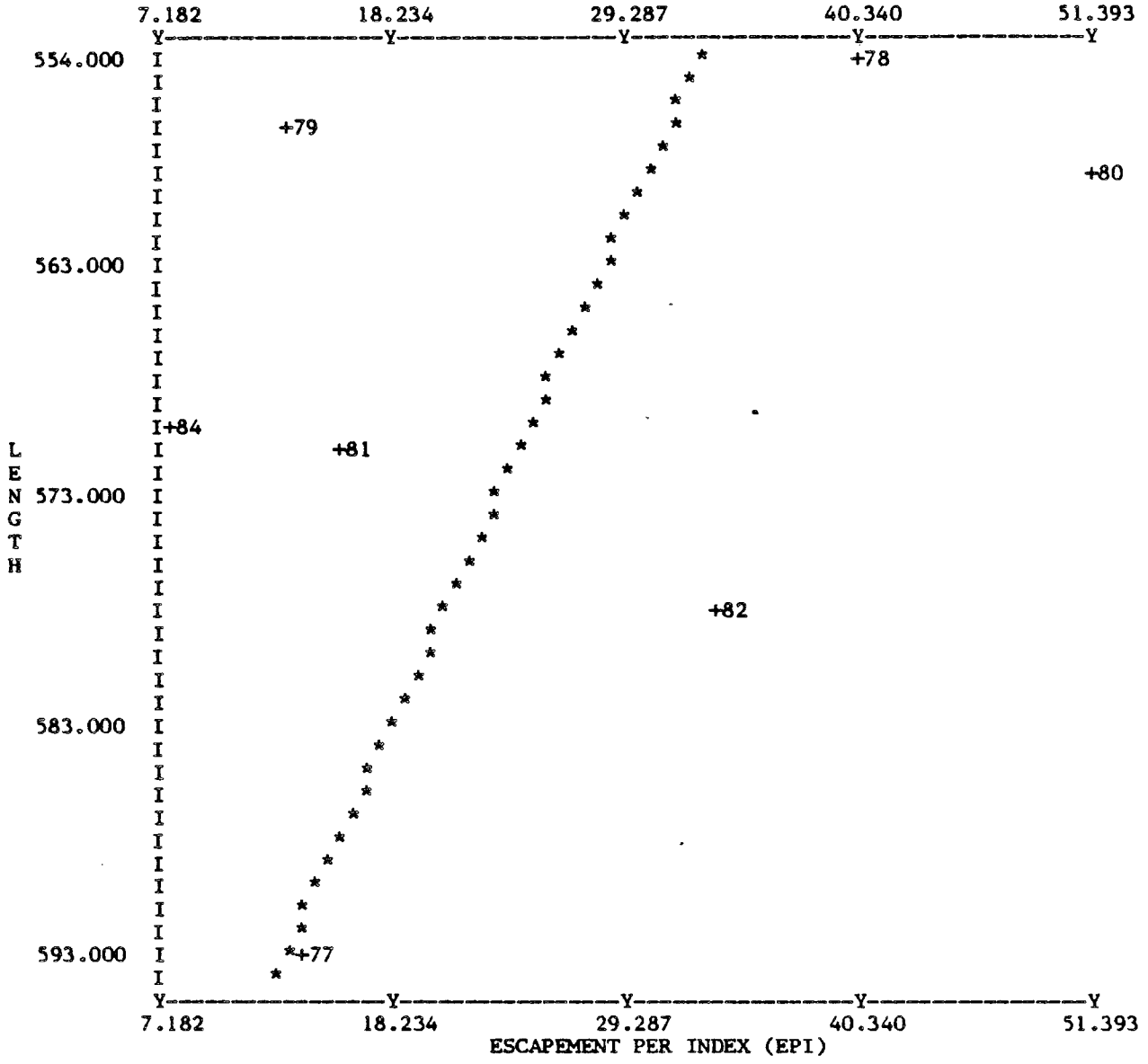
Appendix Figure 4. Power curve fit of Egegik test fish EPI values and mean lengths in Appendix Table 2.



Appendix Figure 5. Power curve fit of Ugashik test fish EPI values and mean lengths in Appendix Table 3.

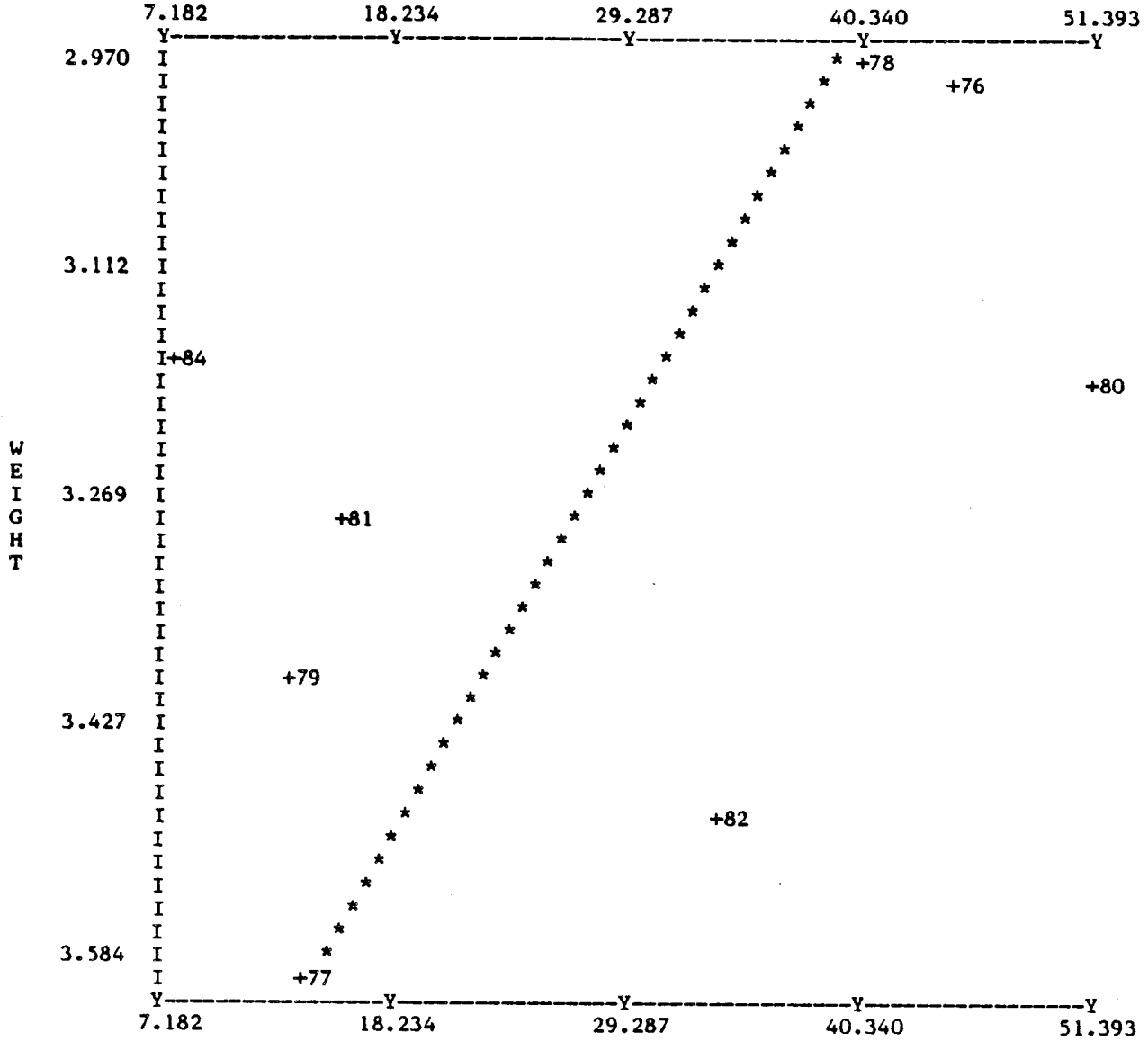


Appendix Figure 6. Power curve fit of Ugashik test fish EPI values and mean weights in Appendix Table 3.



EPI = a + bX where X = length
a = 319.08
b = -.5164
r = -.426 (not recommended for use in 1985)

Appendix Figure 7. Linear regression of Igushik test fish EPI values on mean length in Appendix Table 4.



EPI = a + bX where X = length
a = 158.14
b = -33.9621
r = -.524 (not recommended for use in 1985)

Appendix Figure 8. Linear regression of Igushik test fish EPI values on mean weight in Appendix Table 4.

Appendix Table 1. Historical data on mean weight (kg), mean length (mm), and EPI values, used to compute next season's (1985) regression formula, Kvichak River sockeye salmon test fishery.

YEAR	WEIGHT	LENGTH	ESCAPEMENT	INDEX	ESC/INDEX
80	2.24	514.28	22,505,268	106,315.45	211.684
81	2.55	528.76	1,754,358	20,813.47	84.290
82	2.56	532.31	1,138,840	17,718.46	64.048
83	2.28	513.52	3,569,983	13,233.63	269.766
84	2.28	518.94	10,490,669	45,584.10	230.139

Note: Length and weight data from test fishing samples.

Mean daily test fish indices NOT weighted by fathom hours.

EPI values based on total escapement divided by total mean daily test fish indices.

1979 EPI not used because test fishing ended prematurely (Meacham 1980). Other data prior to 1979 not used because no test fish length or weight samples available.

Linear regression formulas for 1985 field season are:

$EPI = a + b X$

if X = length
then a = 5567.19
b = -10.3443
r = -.960

if X = weight
then a = 1482.16
b = -550.0314
r = -.949

Appendix Table 2. Historical data on mean weight (kg), mean length (mm), and EPI values, used to compute next season's (1985) regression formula, Egegik River sockeye salmon test fishery.

YEAR	WEIGHT	LENGTH	ESCAPEMENT	INDEX	ESC/INDEX
79	2.70	548.39	1,032,042	23,979.89	43.377
80	2.25	524.82	1,060,860	13,312.01	65.076
81	2.64	543.96	649,680	18,766.09	47.455
82	2.98	568.75	1,034,628	30,361.16	24.632
83	2.56	536.60	792,282	16,276.12	54.231
84	2.60	542.74	1,165,320	26,947.22	48.578

Note: Length and weight data from test fishing samples.

Mean daily test fish indices NOT weighted by fathom hours.

EPI values based on total escapement divided by total mean daily test fish indices.

1978 EPI not used because test fishing site was changed in 1979 (Meacham 1980). Other data prior to 1978 not used because no test fishing length or weight samples available.

Power curve regression formulas for 1985 field season are:

$EPI = a\ X^{B}$

if X = length

then a = 215516×10^{23}
b = -9.7522
r = -.832

if X = weight

then a = 880.212
b = -3.0917
r = -.904

Appendix Table 3. Historical data on mean weight (kg), mean length (mm), and EPI values, used to compute next season's (1985) regression formula, Ugashik River sockeye salmon test fishery.

YEAR	WEIGHT	LENGTH	ESCAPEMENT	INDEX	ESC/INDEX
79	2.62	537.820	1,700,904	42,880.32	39.666
80	2.37	518.760	3,321,384	85,711.35	38.751
81	2.91	560.420	1,326,762	73,861.19	17.963
82	3.13	571.760	1,157,526	48,056.64	24.087
83	2.42	521.600	1,000,614	15,485.45	64.616
84	2.43	522.860	1,241,418	20,137.66	61.647

Note: Length and weight data from test fishing samples.

Mean daily test fish indices NOT weighted by fathom hours.

EPI values based on total escapement divided by total mean daily test fish indices.

1978 EPI not used because test fishing site was changed in 1979 (Meacham 1980). Other data prior to 1978 not used because no test fishing length or weight samples available.

Power curve regression formulas for 1985 field season are:

$EPI = a\ X^{B}$

if X = length

then a = 245942 X 10^{25}
b = -10.5523
r = -.856

if X = weight

then a = 909.809
b = -3.3529
r = -.860

Appendix Table 4. Historical data on mean weight (kg), mean length (mm), and EPI values, used to compute next season's (1985) regression formula, Igushik River sockeye salmon test fishery.

YEAR	WEIGHT	LENGTH	ESCAPEMENT	INDEX	ESC/INDEX
76	3.00	n/a	186,120	4,104.20	39.156
77	3.60	594.000	98,970	7,273.00	12.281
78	2.97	554.000	536,154	13,152.00	39.156
79	3.40	558.000	589,560	45,013.00	21.239
80	3.10	560.000	1,987,530	38,673.00	34.677
81	3.20	572.000	591,144	37,974.70	25.718
82	3.50	579.000	423,768	12,637.70	16.760
84	3.18	570.000	184,872	25,742.54	31.093

Note: Length and weight data from test fishing samples after 1978, and from Igushik section commercial catch samples in 1976 and 1977.

Mean daily test fish indices NOT weighted by fathom hours.

EPI values based on total escapement divided by total mean daily test fish indices.

1983 data not used because unusually low lengths and weights (Bucher and Frederickson 1984). Length data not available in 1976.

The linear regression formulas below are NOT recommended for use in estimating 1985 EPI values due to low correlation coefficients.

EPI = a + bX

if X = length

then a = 319.08
b = -.5164
r = -.426 (NOT statistically significant)

if X = weight

then a = 158.14
b = -33.9621
r = -.524 (NOT statistically significant)

Appendix Table 5. Kvichak River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984.

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
June	20	1	1	50	27.35	0			
	20	2	2	50	18.27	0			
	21	3	1	50	32.57	0			
	21	4	2	50	19.32	0			
	21	5	1	50	31.71	0			
	21	6	2	50	19.06	0			
	22	7	1	50	27.25	0			
	22	8	2	50	15.91	0			
	22	9	1	50	28.89	0			
	22	10	2	50	20.79	0			
	23	11	1	50	25.84	11	51.08	1.79	495.00
	23	12	2	50	18.60	0			
	23	13	1	50	23.89	5	25.12	2.11	521.00
	23	14	2	50	26.70	0			
	24	15	1	50	22.00	33	180.00	2.09	527.00
	24	16	2	25	3.45	30	2086.96	2.22	526.00
	24	17	1	25	7.77	14	432.43	2.17	518.00
	24	18	2	25	3.03	30	2376.24	2.36	521.00
	25	19	1	25	4.62	3	155.84	2.27	529.00
	25	20	2	25	15.53	6	92.72	2.25	515.00
	25	21	1	25	5.37	16	715.08	2.05	511.00
	25	22	2	25	18.02	0			
	26	23	1	25	4.20	18	1028.57	2.05	502.00
	26	24	2	25	12.42	15	289.86	2.04	517.00
	26	25	1	25	38.48	0			
	26	26	2	25	14.66	0			
	27	27	1	25	26.64	2	18.02	2.37	545.00
	27	28	2	25	22.08	1	10.87	2.33	491.00
	27	29	1	25	2.55	67	6305.88		
	27	30	2	25	3.47	23	1590.78		
	28	31	1	25	1.65	46	6690.91	2.37	510.00
	28	32	2	25	1.22	64	12590.16	2.35	518.00
	28	33	1	25	2.83	17	1441.70	2.37	525.00
	28	34	2	25	2.62	28	2564.89	2.13	503.00
	29	35	1	25	2.02	44	5227.72	2.24	517.00
	29	36	2	25	1.41	51	8680.85	2.34	532.00
	29	37	1	25	3.18	79	5962.26	2.27	525.00
	29	38	2	25	7.33	4	130.97	2.09	505.00
	30	39	1	25	4.32	49	2722.22	2.15	513.00
	30	40	2	25	4.75	26	1313.68	2.16	516.00
	30	41	1	25	22.68	19	201.06	1.92	509.00
	30	42	2	25	15.89	2	30.21	2.29	537.00

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Appendix Table 5. Kvichak River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984 (continued).

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
July	1	43	1	25	4.05	13	770.37	2.15	
	1	44	2	25	1.95	59	7261.54	2.36	
	1	45	1	25	23.84	4	40.27	2.20	546.00
	1	46	2	25	11.71	23	471.39	2.40	546.00
	2	47	1	25	4.55	21	1107.69	2.19	522.00
	2	48	2	25	2.25	32	3413.33	2.19	511.00
	2	49	1	25	2.21	16	1737.56	2.48	534.00
	2	50	2	25	1.84	57	7434.78	2.22	516.00
	3	51	1	25	2.33	22	2266.09	2.09	513.00
	3	52	2	25	2.15	85	9488.37	2.22	516.00
	3	53	1	25	14.59	7	115.15	2.43	551.00
	3	54	2	25	2.82	102	8680.85	2.18	515.00
	4	55	1	25	1.97	38	4629.44	2.27	527.00
	4	56	2	25	3.17	18	1362.78	2.39	530.00
	5	57	1	25	2.51	33	3155.38	2.16	516.00
	5	58	2	25	3.60	33	2200.00	2.05	506.00
	5	59	1	25	2.94	21	1714.29	2.06	514.00
	5	60	2	25	3.59	12	802.23	2.22	520.00
	6	61	1	25	1.95	20	2461.54	2.10	526.00
	6	62	2	25	3.43	29	2029.15	2.21	519.00
	6	63	1	25	1.93	19	2362.69	2.29	520.00
	6	64	2	25	2.64	52	4727.27	2.41	525.00
	7	65	1	25	1.75	42	5760.00	2.26	523.00
	7	66	2	25	3.35	44	3152.24	2.57	537.00
	7	67	1	25	2.33	31	3193.13	2.62	530.00
	7	68	2	25	2.88	36	3000.00	2.88	529.00
	8	69	1	25	2.10	41	4685.71	2.44	524.00
	8	70	2	25	2.79	41	3526.88	2.52	515.00
	8	71	1	25	4.28	26	1457.94	2.44	525.00
	8	72	2	25	6.63	28	1013.57	2.50	522.00
	9	73	1	25	6.12	13	509.80	2.13	504.00
	9	74	2	25	15.93	41	617.70	1.88	500.00
	9	75	1	25	4.43	15	812.64	2.39	531.00
	9	76	2	25	11.27	10	212.95	1.88	505.00
	10	77	1	25	3.76	9	574.47	2.22	522.00
	10	78	2	25	25.17	23	219.31	2.15	512.00
	10	79	1	25	18.00	4	53.33	2.47	505.00
	10	80	2	25	11.64	1	20.62	1.80	476.00
	11	81	1	25	4.16	24	1384.62	2.03	505.00
	11	82	2	25	5.87	134	5478.71	2.09	507.00
	11	83	1	25	18.61	17	219.24	2.13	510.00
	11	84	2	25	3.52	20	1363.64	2.22	510.00
	12	85	1	25	5.04	70	3333.33	2.07	507.00
	12	86	2	25	7.92	21	636.36	2.07	515.00

Appendix Table 6. Age, length (mid-eye to tail fork, mm) and weight (round weight, kg) statistics for sockeye salmon caught during Kvichak River, Bristol Bay, test fishing, 1984.

	Age Group				
	4 2	5 2	5 3	6 3	Total
Males					
Percent	6.00	2.60	32.60	1.30	42.50
Mean length	492.54	578.13	518.15	574.00	519.91
Std. error	2.10	3.55	1.14	6.80	0.97
Sample size	105	46	564	23	738
Mean weight	1.98	3.15	2.32	3.19	2.35
Std. error	0.05	0.13	0.03	0.18	0.02
Sample size	38	21	231	14	304
Females					
Percent	5.40	4.00	45.30	2.80	57.50
Mean length	484.95	552.77	510.98	561.98	513.93
Std. error	2.21	2.92	0.79	3.65	0.71
Sample size	94	70	786	49	999
Mean weight	1.82	2.73	2.05	2.84	2.11
Std. error	0.04	0.07	0.02	0.08	0.02
Sample size	38	32	347	24	441
Both Sexes					
Percent	11.40	6.60	77.90	4.10	100.00
Mean length	488.94	562.76	513.98	565.79	516.47
Std. error	1.52	2.26	0.69	3.30	0.58
Sample size	199	116	1,350	72	1,737
Mean weight	1.90	2.90	2.16	2.95	2.21
Std. error	0.03	0.07	0.01	0.08	0.01
Sample size	76	53	578	38	745

Appendix Table 7. Egegik River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984.

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
June	18	1	1	25	31.10	7	54.02	2.81	561.00
	18	2	2	25	10.40	9	207.69	2.97	562.00
	18	3	1	25	31.50	3	22.86	3.10	594.00
	18	4	2	25	8.00	6	180.00	2.76	559.00
	19	5	1	25	25.23	0			
	19	6	2	25	19.00	2	25.26	1.64	477.00
	19	7	1	25	29.10	1	8.25	1.88	513.00
	19	8	2	25	26.90	2	17.84	1.89	522.00
	20	9	1	25	28.20	1	8.51	1.98	491.00
	20	10	2	25	24.10	5	49.79	2.21	521.00
	20	11	1	25	30.10	1	7.97	2.64	549.00
	20	12	2	25	31.30	13	99.68	2.06	513.00
	21	13	1	25	29.10	1	8.25	2.08	490.00
	21	14	2	25	23.41	8	82.02	1.92	502.00
	21	15	1	25	28.40	0			
	21	16	2	25	30.20	7	55.63	2.05	511.00
	22	17	1	25	25.00	4	38.40	2.18	520.00
	22	18	2	25	27.00	9	80.00	2.06	510.00
	22	19	1	25	31.60	0			
	22	20	2	25	29.10	0			
	23	21	1	25	21.90	1	10.96	1.76	495.00
	23	22	2	25	26.60	3	27.07	2.09	549.00
	23	23	1	25	29.80	0			
	23	24	2	25	11.90	15	302.52	2.46	545.00
	24	25	1	25	24.10	14	139.42	2.65	535.00
	24	26	2	25	4.70	17	868.09	2.13	546.00
	25	27	1	25	3.10	10	774.19	0.00	521.00
	25	28	2	25	4.80	13	650.00	0.00	535.00
	25	29	2	25	5.60	31	1328.57	0.00	535.00
	25	30	1	25	21.40	16	179.44	2.40	523.00
	25	31	2	25	11.80	59	1200.00	2.80	554.00
	26	32	1	25	30.40	13	102.63	2.29	521.00
	26	33	2	25	12.10	8	158.68	1.94	502.00
	26	34	1	25	31.60	14	106.33	2.41	523.00
	26	35	2	25	3.80	16	1010.53	2.99	563.00
	27	36	1	25	11.50	47	980.87	2.67	541.00
	27	37	2	25	16.60	22	318.07	2.77	539.00
	27	38	1	25	29.70	6	48.48	2.04	509.00
	27	39	2	25	10.90	14	308.26	2.93	561.00
	28	40	1	25	15.30	4	62.75	1.99	494.00
	28	41	2	25	13.20	45	818.18	2.35	537.00
	28	42	1	25	36.20	1	6.63	4.25	625.00
	28	43	2	25	2.90	39	3227.59	2.73	547.00
	29	44	1	25	7.00	13	445.71	2.60	552.00
	29	45	2	25	2.20	28	3054.55	2.80	541.00
	29	46	1	25	18.70	4	51.34	2.50	544.00
	29	47	2	25	1.30	30	5538.46	2.60	547.00
	30	48	1	25	9.40	33	842.55	2.36	548.00
	30	49	2	25	1.00	41	9840.00	2.69	543.00
	30	50	1	25	15.40	18	280.52	2.36	520.00
	30	51	2	25	3.60	14	933.33	2.60	542.00

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Appendix Table 7. Egegik River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984 (continued).

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
July	1	52	1	25	16.90	21	298.22	2.10	529.00
	1	53	2	25	6.50	29	1070.77	3.00	558.00
	1	54	1	25	5.30	19	860.38	2.50	537.00
	1	55	2	25	2.00	15	1800.00	2.52	542.00
	2	56	1	25	5.00	62	2976.00	2.30	526.00
	2	57	2	25	1.20	24	4800.00	2.80	539.00
	2	58	1	25	34.00	11	77.65	2.20	526.00
	2	59	2	25	8.80	18	490.91	2.90	561.00
	3	60	1	25	15.70	34	519.75	2.13	514.00
	3	61	2	25	7.90	26	789.87	2.28	520.00
	3	62	1	25	31.20	14	107.69	2.47	531.00
	3	63	2	25	8.10	33	977.78	2.25	522.00
	4	64	1	25	5.80	33	1365.52	2.44	530.00
	4	65	2	25	3.90	45	2769.23	2.55	530.00
	4	66	1	25	20.70	16	185.51	2.28	515.00
	4	67	2	25	6.30	32	1219.05	2.25	536.00
	5	68	1	25	11.40	49	1031.58	2.40	538.00
	5	69	2	25	3.20	51	3825.00	2.49	550.00
	5	70	1	25	28.80	21	175.00	2.22	534.00
	5	71	2	25	5.50	31	1352.73	2.39	534.00
	6	72	1	25	2.50	41	3936.00	2.60	547.00
	6	73	2	25	1.00	30	7200.00	2.81	559.00
	6	74	1	25	9.00	18	480.00	2.46	548.00
	6	75	2	25	5.50	38	1658.18	2.19	529.00
	7	76	1	25	4.80	39	1950.00	2.58	516.00
	7	77	2	25	3.30	42	3054.55	2.85	556.00
	7	78	1	25	18.60	24	309.68	2.49	539.00
	7	79	2	25	3.80	24	1515.79	2.63	557.00
	8	80	1	25	6.50	42	1550.77	2.49	546.00
	8	81	2	25	2.90	41	3393.10	2.87	551.00
	8	82	1	25	3.60	40	2666.67	2.47	539.00
	8	83	2	25	2.50	60	5760.00	2.57	553.00
	9	84	1	25	4.30	48	2679.07	2.39	535.00
	9	85	2	25	2.40	27	2700.00	2.89	546.00
	10	86	1	25	30.30	16	126.73	1.90	514.00
	10	87	2	25	11.70	26	533.33	2.83	545.00
	10	88	1	25	30.90	5	38.83	1.83	488.00
	10	89	2	25	9.00	19	506.67	2.11	524.00
	11	90	1	25	17.90	3	40.22	2.61	525.00
	11	91	2	25	12.80	14	262.50	2.34	520.00
	11	92	1	25	30.80	7	54.55	2.13	509.00
	11	93	2	25	30.50	21	165.25	2.27	513.00
	12	94	1	25	25.80	9	83.72	2.12	504.00
	12	95	2	25	12.40	5	96.77	2.50	528.00
	12	96	1	25	30.70	12	93.81	1.75	492.00
	12	97	2	25	18.30	9	118.03	2.11	515.00

Appendix Table 8. Age, length (mid-eye to tail fork, mm) and weight (round weight, kg) statistics for sockeye salmon caught during Egegik River, Bristol Bay, test fishing, 1984.

	Age Group							
	4 2	4 3	5 2	5 3	6 3	6 4	7 4	Total
Males								
Percent	11.70	0.20	1.90	28.30	15.20	0.60	0.20	58.10
Mean length	500.26	331.50	567.31	518.23	594.93	542.00	546.00	535.98
Std. error	2.13	3.50	10.95	1.72	2.78	16.53	18.00	1.26
Sample size	99	2	16	238	128	5	2	490
Mean weight	2.06	0.50	2.97	2.17	3.55	2.96	2.82	2.54
Std. error	0.05		0.28	0.04	0.06	0.46	0.28	0.03
Sample size	56	1	10	138	79	3	2	289
Females								
Percent	3.60		2.00	17.30	18.90		0.10	41.90
Mean length	499.17		563.00	512.34	571.43		576.00	540.43
Std. error	5.08		4.70	1.93	2.06			1.32
Sample size	30	0	17	146	159	0	1	353
Mean weight	1.75		2.83	1.96	2.83			2.38
Std. error	0.06		0.06	0.03	0.04			0.02
Sample size	18	0	10	88	110	0	0	226
Both Sexes								
Percent	15.30	0.20	3.90	45.60	34.10	0.60	0.30	100.00
Mean length	500.00	331.50	565.10	516.00	581.91	542.00	556.00	537.85
Std. error	2.02	3.50	5.84	1.29	1.68	16.53	12.00	0.91
Sample size	129	2	33	384	287	5	3	843
Mean weight	1.99	0.50	2.90	2.09	3.15	2.96	2.82	2.47
Std. error	0.04		0.14	0.02	0.03	0.46	0.28	0.02
Sample size	74	1	20	226	189	3	2	515

Appendix Table 9. Ugashik River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984.

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
June	24	1	1	25	15.32	0			
	24	2	2	25	28.60	1	8.39	8.39	497.00
	24	3	1	25	21.88	0			
	24	4	2	25	22.53	2	21.30	2.08	509.00
	25	5	1	25	19.90	1	12.06	1.38	447.00
	25	6	2	25	24.13	2	19.89		
	25	7	1	25	26.82	1	8.95	0.00	537.00
	25	8	2	25	31.43	1	7.64	3.60	602.00
	26	9	1	25	17.27	0			
	26	10	2	25	17.62	1	13.62	2.46	540.00
	26	11	1	25	20.24	0			
	26	12	2	25	24.86	0			
	27	13	1	25	15.81	1	15.18	0.00	604.00
	27	2	14	25	26.29	2	18.26	2.79	560.00
	27	15	1	25	30.39	0			
	27	16	2	25	21.19	1	11.33	2.10	495.00
	28	17	1	25	14.66	1	16.37	2.36	547.00
	28	18	2	25	20.06	1	11.96	2.34	528.00
	28	19	1	25	30.71	1	7.82	2.32	531.00
	28	20	2	25	21.19	0			
	29	21	1	25	15.56	2	30.85	3.04	567.00
	29	22	2	25	15.60	10	153.85	2.19	527.00
	29	23	1	25	30.58	2	15.70	2.17	513.00
	29	24	2	25	31.48	6	45.74	2.29	528.00
	30	25	1	25	15.60	1	15.38	1.92	483.00
	30	26	2	25	16.00	5	75.00	2.98	567.00
	30	27	1	25	31.26	3	23.03	2.27	522.00
	30	28	2	25	34.78	6	41.40	1.94	508.00
July	1	29	1	25	18.48	1	12.99	1.32	491.00
	1	30	2	25	18.74	4	51.23	2.42	544.00
	1	31	1	25	30.70	1	7.82	2.96	578.00
	1	32	2	25	30.91	4	31.06	2.80	546.00
	2	33	1	25	16.23	2	29.57	2.48	555.00
	2	34	2	25	16.15	3	44.58	2.29	523.00
	2	35	1	25	29.60	3	24.32	2.29	527.00
	2	36	2	25	28.70	4	33.45	3.10	571.00
	3	37	1	25	19.63	1	12.23	1.76	487.00
	3	38	2	25	21.17	8	90.69	2.56	541.00
	4	39	1	25	16.44	3	43.80	2.30	535.00
	4	40	2	25	15.36	1	15.62	1.92	495.00
	4	41	1	25	19.42	2	24.72	1.62	501.00
	4	42	2	25	16.36	6	88.02	2.30	527.00
	5	43	1	25	19.16	6	75.16	2.42	534.00
	5	44	2	25	20.00	5	60.00	2.21	525.00
	5	45	1	25	17.89	6	80.49	2.37	544.00
	5	46	2	25	20.95	10	114.56	2.14	516.00

-Continued-

Appendix Table 9. Ugashik River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984 (continued).

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
July	6	47	1	25	21.56	8	89.05	2.45	524.00
	6	48	2	25	12.28	12	234.53	2.12	521.00
	6	49	1	25	15.86	17	257.25	2.18	523.00
	6	50	2	25	19.18	17	212.72	2.33	529.00
	7	51	1	25	15.51	5	77.37	2.19	521.00
	7	52	2	25	16.25	28	413.54	2.28	524.00
	7	53	1	25	5.47	14	614.26	2.19	519.00
	7	54	2	25	7.06	10	339.94	2.40	526.00
	8	55	1	25	14.63	11	180.45	2.29	500.00
	8	56	2	25	10.42	14	322.46	1.96	526.00
	8	57	1	25	11.34	17	359.79	1.96	504.00
	8	58	2	25	10.98	11	240.44	2.08	514.00
	9	59	1	25	11.55	7	145.45	1.87	493.00
	9	60	2	25	15.33	30	469.67	2.35	533.00
	9	61	1	25	16.34	21	308.45	2.26	526.00
	9	62	2	25	19.35	15	186.05	2.20	526.00
	10	63	1	25	16.23	5	73.94	2.28	533.00
	10	64	2	25	21.85	7	76.89	2.14	519.00
	10	65	1	25	9.42	11	280.25	2.06	518.00
	10	66	2	25	13.23	15	272.11	2.23	525.00
	11	67	1	25	14.12	2	33.99		
	11	68	2	25	.92	24	6260.87	2.13	511.00
	11	69	1	25	10.60	8	181.13		
	11	70	2	25	1.32	15	2727.27		
	12	71	1	25	10.77	7	155.99	2.31	514.00
	12	72	2	25	1.25	30	5760.00	2.11	512.00
	13	73	1	25	5.44	12	529.41	1.97	500.00
	13	74	2	25	.87	34	9379.31	2.49	526.00
	13	75	1	25	1.48	13	2108.11	2.59	534.00
	13	76	2	25	.83	43	12433.74	2.42	539.00
	14	77	1	25	15.60	2	30.77	2.15	511.00
	14	78	2	25	3.12	29	2230.77	2.58	533.00
	14	79	1	25	16.98	13	183.75	2.32	522.00
	14	80	2	25	17.11	11	154.30	2.37	533.00
	15	81	1	25	15.95	2	30.09	1.95	512.00
	15	82	2	25	14.23	19	320.45	2.37	531.00
	16	83	1	25	16.40	21	307.32	2.21	522.00
	16	84	2	25	5.72	7	293.71	2.30	528.00
	16	85	1	25	1.05	24	5485.71	2.12	517.00
	16	86	2	25	.93	33	8516.13	1.95	513.00
	17	87	1	25	.85	14	3952.94	2.07	514.00
	17	88	2	25	.53	8	3622.64	2.27	527.00
	17	89	1	25	1.13	13	2761.06	2.16	524.00
	17	90	2	25	20.38	13	153.09	2.06	521.00

Appendix Table 10. Age, length (mid-eye to tail fork, mm) and weight (round weight, kg) statistics for sockeye salmon caught during Ugashik River, Bristol Bay, test fishing, 1984.

	Age Group								Total
	4 1	4 2	4 3	5 2	5 3	5 4	6 2	6 3	
Males									
Percent	0.30	27.40	0.70	7.40	18.20		0.10	3.10	57.20
Mean length	529.50	508.35	394.20	574.30	518.03		568.00	590.10	523.21
Std. error	44.50	1.58	9.87	5.40	2.33			6.14	1.34
Sample size	2	185	5	50	123	0	1	21	387
Mean weight	1.90	2.05	0.90	3.17	2.16		3.20	3.45	2.29
Std. error		0.03	0.08	0.11	0.04			0.13	0.02
Sample size	1	160	5	43	108	0	1	19	337
Females									
Percent	0.10	10.20		11.80	17.20	0.10		3.40	42.80
Mean length	547.00	500.68		550.85	510.06	520.00		552.35	522.54
Std. error		2.40		3.12	1.87			7.24	1.40
Sample size	1	69	0	80	115	1	0	23	289
Mean weight	2.42	1.85		2.56	1.94	2.10		2.59	2.14
Std. error		0.03		0.05	0.03			0.10	0.02
Sample size	1	66	0	68	94	1	0	20	250
Both Sexes									
Percent	0.40	37.60	0.70	19.20	35.40	0.10	0.10	6.50	100.00
Mean length	533.87	506.27	394.20	559.89	514.16	520.00	568.00	570.35	522.92
Std. error	29.67	1.32	9.87	2.83	1.51			4.79	0.97
Sample size	3	254	5	130	238	0	1	44	676
Mean weight	2.03	2.00	0.90	2.80	2.05	2.10	3.20	3.00	2.23
Std. error		0.02	0.08	0.05	0.03			0.08	0.02
Sample size	2	226	5	111	202	1	1	39	587

Appendix Table 11. Igushik River sockeye salmon test fishing catch, fishing time, indices, mean weight, and length by set and station, 1984.

MONTH	DAY	SET NO.	STATION NO.	LENGTH OF NET (FATHOMS)	FISHING TIME (MIN)	CATCH	INDEX	MEAN WEIGHT (KG)	MEAN LENGTH (MM)
June	18	1	1	25	27.30	6	52.75	2.80	550.00
	18	2	1	25	24.00	2	20.00	3.90	603.00
	19	3	1	25	23.00	8	83.48	2.90	556.00
	19	4	1	25	30.00	3	24.00	3.00	561.00
	20	5	1	25	27.50	8	69.82	3.00	566.00
	20	6	1	25	13.50	18	320.00	3.20	578.00
	21	7	1	25	26.50	6	54.34	3.00	570.00
	21	8	1	25	19.50	25	307.69	3.20	565.00
	22	9	1	25	32.50	12	88.62	3.20	579.00
	22	10	1	25	10.00	40	960.00	3.30	565.00
	23	11	1	25	16.00	28	420.00	3.30	573.00
	23	12	1	25	9.00	34	906.67	3.00	552.00
	24	13	1	25	5.00	19	912.00	3.10	568.00
	25	14	1	25	7.00	48	1645.71	3.20	574.00
	25	15	1	25	8.00	19	570.00	3.20	570.00
	26	16	1	25	10.00	68	1632.00	3.10	573.00
	26	17	1	25	4.00	23	1380.00	2.90	564.00
	27	18	1	25	4.00	27	1620.00	3.20	570.00
	27	19	1	25	11.50	9	187.83	3.00	560.00
	28	20	1	25	10.50	9	205.71	2.90	564.00
	28	21	1	25	10.50	9	205.71	2.90	564.00
	29	22	1	25	7.50	16	512.00	3.00	559.00
	29	23	1	25	15.00	13	208.00	3.30	575.00
	30	24	1	25	22.50	37	394.67	3.30	576.00
	30	25	1	25	3.00	27	2160.00	3.80	594.00
July	1	26	1	25	4.50	19	1013.33	3.40	576.00
	1	27	1	25	5.00	46	2208.00	2.90	561.00
	2	28	1	25	7.00	41	1405.71	3.40	581.00
	2	29	1	25	4.50	34	1813.33	3.10	562.00
	3	30	1	25	3.50	21	1440.00	3.00	567.00
	3	31	1	25	5.00	19	912.00	3.20	577.00
	4	32	1	25	5.00	18	864.00	2.90	561.00
	4	33	1	25	4.50	19	1013.33	3.30	570.00
	5	34	1	25	5.50	41	1789.09	3.10	567.00
	5	35	1	25	4.50	17	906.67	3.00	570.00
	6	36	1	25	11.00	26	567.27	3.20	570.00
	6	37	1	25	2.50	20	1920.00	3.10	564.00
	7	38	1	25	7.00	21	720.00	3.10	577.00
	7	39	1	25	6.50	29	1070.77	3.20	575.00
	8	0	1	25	5.00	19	912.00	3.20	570.00
	9	0	1	25	5.00	19	912.00	3.20	570.00
	10	40	1	25	6.00	33	1320.00	3.00	560.00
	10	41	1	25	8.50	43	1214.12	3.20	575.00
	11	42	1	25	4.00	31	1860.00	3.30	572.00
	11	43	1	25	7.50	39	1248.00	3.20	575.00
	12	44	1	25	3.50	29	1988.57	3.30	572.00
	12	45	1	25	5.00	38	1824.00	3.10	571.00
	13	46	1	25	2.50	23	2208.00	3.30	573.00
	13	47	1	25	4.00	32	1920.00	3.20	572.00
	14	48	1	25	9.50	15	378.95	2.90	559.00

1984 NUSHAGAK RIVER CHINOOK SALMON ESCAPEMENT ESTIMATION FROM SUBSISTENCE CATCH MONITORING

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INTRODUCTION

The Lewis Point, Nushagak River, subsistence catch monitoring program has been conducted by Alaska Department of Fish and Game (ADF&G) personnel for the last three summers, 1982-1984 (Minard 1982; Minard et al. 1983). The goal of this program is to estimate the number of chinook salmon *(Oncorhynchus tshawytscha)* entering the Nushagak River drainage to spawn by indexing subsistence catches made near the River mouth. Estimates of spawner abundance are needed to ensure that escapement levels are attained, subsistence harvest needs are met, and surplus chinook salmon can be harvested within the commercial fishery. Specific objectives are: 1) to collect catch per unit of effort data for the Lewis Point chinook salmon subsistence fishery, 2) to sample subsistence catches to obtain age, sex, and size data for chinook as well as sockeye salmon *(O. nerka)*, and 3) to develop models based upon subsistence catch data which can be used to predict total chinook salmon spawning escapement.

METHODS

Subsistence Catch Monitoring

Three subsistence fishing camps, locally referred to as First, Second, and Third Place, have been operated at Lewis Point (Figure 1). Data for the present study have been collected at First Place, the camp closest to the Nushagak River mouth, since fishing effort and patterns have been fairly consistent over time within this camp.

Subsistence fishery catch information was collected by an ADF&G technician stationed at Lewis Point and reported daily, via radio-telephone, to ADF&G management staff members stationed in Dillingham.

Verbal interviews with fishermen were used to estimate chinook salmon catches for 4 and 5 June. Actual observations on fishing activities by the technician were used to estimate catches for 6 to 28 June. Twenty or more gill nets were sometimes fished at First Place during a single day, but only 7 or 8 gill nets were fished regularly throughout the season and were made

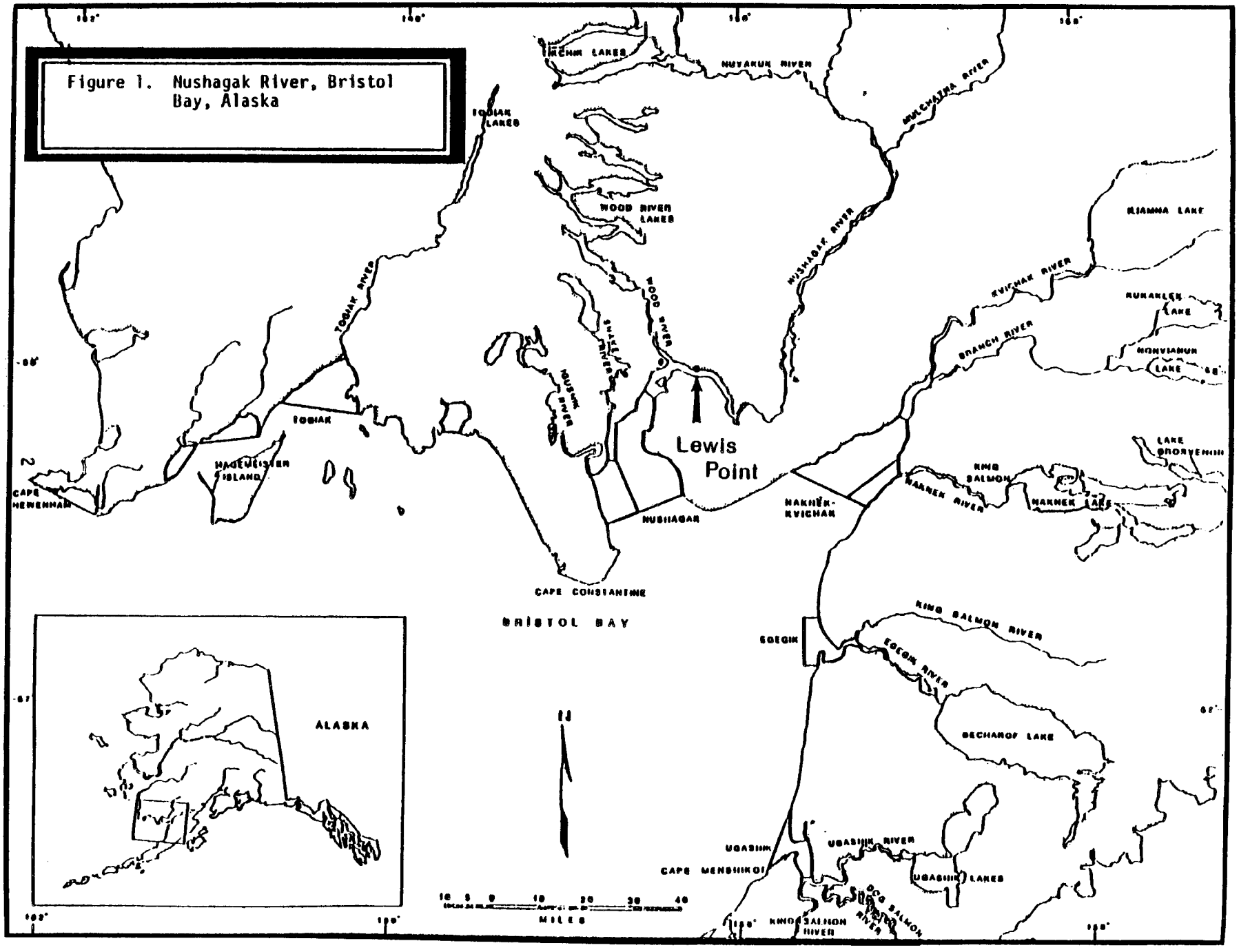
Figure 1. Nushagak River, Bristol Bay, Alaska
Lewis Point
NUSHAGAK
NAKNEK-KVICHAK
KOLOMA RIVER
WOOD RIVER LAKES
WOOD RIVER
NUSHAGAK RIVER
TOGIAK RIVER
TOGIAK
TOGIAK LAKES
HAGEMEISTER ISLAND
CAPE NEWENHAM
CAPE CONSTANTINE
BRISTOL BAY
KVICHAK RIVER
BRANCH RIVER
KIAMNA LAKE
NONVIANUK LAKE
NUNAKLEK LAKE
NAKNEK RIVER
NAKNEK LAKE
KING SALMON
LAKE BROOKS
EGEGIK
EGEGIK RIVER
KING SALMON RIVER
BECHAROF LAKE
UGASHIK
UGASHIK RIVER
UGASHIK LAKES
CAPE MENSHIKOF
ALASKA
MILES

with web having a large stretched mesh size (17.7 to 21.6 cm [7 to 8-1/2 inches]). These gill nets were designated as index nets and monitored throughout the season. On days when the technician was not able to check every subsistence net being fished, catches in index nets were used to estimate total daily catch (S) using the following relationship:

$$S = N \times CI, \text{ where}$$

N = total number of nets fished during day, and

CI = average daily catch of index nets.

CI was calculated as follows:

$$CI = \frac{\sum_{i=1}^{NI} C_i}{NI}, \text{ where}$$

C_i = subsistence catch of chinook salmon in i^{th} net for both high tides during a fishing day, and

NI = number of index nets checked.

In addition to determining CI, the average chinook salmon catch for all subsistence nets was calculated for each high tide (CPUE) and each day (CA) as follows:

$$CPUE = \frac{T}{NT}, \text{ where}$$

T = total subsistence catch for all nets checked (index nets as well as non-index nets), and

NT = total number of nets checked;

$$CA = \frac{\sum_{i=1}^{NT} CT_i}{NT}, \text{ where}$$

CT_i = the sum of CPUE values for a single day for the i^{th} net.

After the season, average chinook salmon catch per net for the season (mean of all daily CT values, hereafter referred to as the grand mean) was compared with grand mean values for 1982 and 1983 using a t-test for means with unequal variances (Sokal and Rohlf 1969).

Calculation of Daily Index

Test fishing indices were calculated for several index nets during each high tide. Fishing time for each index net was either determined by direct observation or estimated. A net was considered to have begun fishing when the first 3.6 m (2 fm) of its length were covered with water by the incoming tide. A net was considered to have ceased fishing when all but 3.6 m (2 fm) were exposed by the outgoing tide, or it was pulled from the water by a fisherman.

Index points were calculated for each index net for each high tide using the following equation:

$$I_i = \frac{CH_i}{(NL_i \times T_i)} \times 100, \text{ where}$$

I_i = index for the i^{th} net,

CH_i = subsistence catch for the i^{th} net,

NL_i = length of i^{th} net (fathoms or m), and

T_i = time i^{th} net was fished (hours).

Mean index (MI) for each tide was calculated using the equation:

$$MI = \frac{\sum_{i=1}^{NI} I_i}{NI}.$$

Daily index was the sum of mean indices for each tide during a single day.

Escapement Estimation

During the season, predictions of chinook salmon escapement were made using a linear regression model:

$EPI = a + bG$, where

EPI = escapement per index point,

G = mean girth of chinook salmon caught by subsistence fishermen, and

a and b = constants denoting the intercept and slope of the line, respectively.

Since only two years of data were available, this model was not considered to be of great predictive value.

After the season, EPI estimates were adjusted based upon information from aerial surveys (Bucher 1984) and sampling conducted on conjunction with a Pacific salmon enumeration sonar project located further upriver near Portage Creek (Figure 1). Sampling near Portage Creek was conducted with drift gill nets and beach seines.

Accuracy of daily cumulative escapement estimates made during the season was expressed as the percent error (PI) of within- and post-season estimates:

$$PI = \frac{(WE-PE)}{PE} \times 100, \text{ where}$$

WE = within-season estimate, and

PE = post-season estimate.

Age, Sex, and Size

Chinook salmon caught by Lewis Point subsistence fishermen were sampled to obtain age, sex, weight (nearest 10 g), length (mid-eye to tail fork), and maximum girth (mm) data. Ages were obtained from a single scale taken from each fish. Date of capture and gillnet mesh size were recorded for all samples. Sockeye salmon caught by subsistence fishermen were sampled as time allowed.

Climatological and Hydrological Observations

Sky cover, precipitation (mm), wind direction and speed (km per hour), mean air and water temperatures (°C), and turbidity were recorded at 0800 and 2000 hour each day. Daily mean precipitation and temperatures were calculated after the season.

RESULTS AND DISCUSSION

Subsistence Catch Monitoring

Chinook salmon catch at First Place was estimated to be 713, about 7.3% of the total estimated subsistence harvest of 9,769 for the entire Nushagak River drainage. Average catch per net at First Place was estimated to be 2.69 chinook salmon, but daily catches ranged from 0 to 17.67 (Table 1). Grand mean chinook salmon catch per net in 1984 (2.87) was less than either of the preceding two years (1983, 4.80; 1982, 7.20) (Table 2). However, these differences were not statistically significant (t-test, $P>0.05$). In all three years, greatest daily catches per net were made during 20 to 28 June.

Table 1. Chinook salmon catch per unit of effort (CPUE), mean daily index, and cumulative index based upon subsistence catches at Lewis Point, Nushagak River, 1984.

Date	CPUE[1]	Mean Daily Index (chinook per 100 fathom hrs)	Cumulative Index
6/ 4	0.00	0.00	0.00
5	3.00	0.00	0.00
6	0.43	0.52	0.52
7	0.14	0.48	1.00
7	0.14	0.27	1.27
8	0.38	0.94	2.21
8	0.00	0.00	2.21
9	0.13	0.26	2.47
9	0.00	0.00	2.47
10	0.00	0.00	2.47
10	0.00	0.00	2.47
11	0.00	0.00	2.47
11	0.11	0.30	2.77
12	0.13	0.00	2.77
12	0.00	0.00	2.77
13	0.00	0.00	2.77
13	0.13	0.00	2.77
14	1.00	0.93	3.70
14	0.63	2.22	5.92
15	0.67	0.00	5.92
15	0.00	0.00	5.92
16	0.44	0.00	5.92
16	0.25	0.00	5.92
17	0.60	0.00	5.92
17	0.14	0.00	5.92
18	0.30	0.11	6.03
18	0.25	0.00	6.03
19	1.20	0.39	6.42
20	0.50	0.00	6.42
20	0.63	0.00	6.42
21	0.00	0.00	6.42
21	0.13	0.00	6.42
22	2.00	3.33	9.75
22	10.20	70.99	80.74
23	9.33	55.55	136.29
23	6.75	51.19	187.48
24	17.67	43.87	231.35
24	3.33	10.83	242.18
25	12.50	147.92	390.10
25	5.00	18.52	408.62
26	13.67	40.55	449.17
26	2.00	22.22	471.39
27	10.33	38.24	509.63
27	0.00	0.00	509.63
28	17.50	68.89	578.52
Mean	2.69	Total 1578.52	
Std. Error	4.85		

[1] Chinook salmon catch per net for all nets which were checked (index and non-index nets).

Table 2. Mean chinook salmon daily catch per subsistence net, Lewis Point, Nushagak River, 1982-1984[1].

Date	1982	1983	1984	Three Year Average
6/ 1		1.0		0.3
2	2.0	0.0		0.7
3	30.0	0.0		10.0
4	1.0	0.0	0.0	0.3
5	2.0	2.0	3.0	2.3
6/ 6	1.0	1.0	0.4	0.8
7	0.5	0.5	0.1	0.4
8	0.5	0.0	0.2	0.2
9	-	0.3	0.1	0.1
10	0.0	0.8	0.0	0.3
6/11	0.7	0.0	0.1	0.3
12	0.2	0.2	0.1	0.2
13	0.4	0.0	0.1	0.2
14	0.3	0.0	0.8	0.4
15	0.0	0.1	0.3	0.1
6/16	0.2	0.0	0.4	0.1
17	0.1	0.1	0.1	0.1
18	0.0	0.6	0.3	0.3
19	0.0	0.9	1.2	0.7
20	0.0	9.8	0.6	3.5
6/21	35.5	27.9	0.1	21.2
22	34.5	13.7	6.1	18.1
23	36.3	7.0	8.0	17.1
24	12.3	21.4	10.5	14.7
25	5.0	0.5	8.8	4.8
6/26	47.5	36.8	7.8	30.7
27	5.0		5.2	3.4
28	0.5		17.5	9.0
29	1.0			0.5
30	-			-
7/ 1	-			-
2	0.0			0.0
3	6.7			6.7
4	0.0			0.0
5	0.7			0.7
Grand Mean	7.2	4.80	2.87	4.49
Std. error	13.6	9.66	4.51	7.59

[1] Chinook salmon catch per net for all nets which were checked (index and non-index nets).

Escapement Estimates

This was the first attempt to estimate chinook salmon spawning escapement from subsistence catch data collected at Lewis Point. A total of 578.52 subsistence catch index points were obtained during the season (Table 1). About 98% of the index points were obtained during 22 to 28 June. Cumulative chinook salmon spawning escapement was estimated to be 92,600, based upon an EPI value of 260.

After the season, data from aerial surveys (Bucher 1984) and the Portage Creek Pacific salmon enumeration project indicated that only 55,142 chinook salmon (67.8% of the total post-season escapement estimate of 81,330) had passed Lewis Point by 28 June (Table 3, Figure 2). This estimate was 70% less than the one made during the season based upon the linear regression model. The post-season estimate of EPI, based upon estimated escapement, was 95.32.

While substantial errors were associated with estimates made during the 1984 season, it is hoped that this project will become a more accurate estimator of chinook salmon escapement as more years of data become available. However, catches at Lewis Point did accurately reflect daily trends in chinook salmon spawning escapement (Table 3). This information provided the earliest indication of chinook salmon escapement which could be used for management of the Nushagak District chinook salmon commercial fishery.

Although only three years of data were availble (Table 4), attempts were made to develop a model to predict EPI for the 1985 season based upon chinook salmon length (L), weight (W), and girth (G) data. First, the three size measurements were combined into a single parameter (F) for each of the three years using the following relationship:

$$F = \frac{L \times W}{G} .$$

The relationship between F and EPI was expressed as a linear regression model, which will be used during the 1985 season to predict daily and cumulative chinook salmon abundance:

$$EPI = -444.051 + 43.894\ F,\ R^2 = 0.232.$$

Age, Weight, and Length

A total of 330 chinook and 84 sockeye salmon were sampled for age, sex, and length data. Of these salmon, 92 chinook were weighed and measured for girth, and 18 sockeye salmon weighed.

Age 5_2 (41%) and 6_2 (38%) chinook salmon were most abundant within catches (Table 5). Average length and weight of chinook salmon sampled were 758 mm and 7.7 kg, respectively.

Table 3. Estimates of chinook salmon escapement past the Lewis Point, Nushagak River, subsistence use index fishing site during and after the 1984 fishing season.

Date	Cumulative Index	Cumulative Escapement Estimates (thousands) During Season (A)	After Season (B)		Precent Error[1]
6/ 4	0.00				
5	0.00				
6	0.52		<0.1		
7	1.27	0.2	0.1		100
8	2.21	0.3	0.2		50
6/ 9	2.47	0.4	0.2		100
10	2.47	0.4	0.2		100
11	2.77	0.4	0.3		33
12	2.77	0.4	0.3		33
13	2.77	0.4	0.3		33
6/14	5.92	0.9	0.5		80
15	5.92	0.9	0.5		80
16	5.92	0.9	0.5		80
17	5.92	0.9	0.5		80
18	6.03	1.0	0.5		100
6/19	6.42	1.0	0.6		67
20	6.42	1.0	0.6		67
21	6.42	1.0	0.6		67
22	80.74	12.9	7.9		63
23	187.48	30.0	17.8		69
6/24	242.18	38.7	23.1		68
25	408.62	62.4	39.0		60
26	471.39	75.4	44.9		68
27	509.63	81.5	48.6		68
28	578.52	92.6	55.1		68
Totals	578.52	92.6	55.1	Overall	70

[1] Percent Error = $\frac{A-B}{B} \times 100$

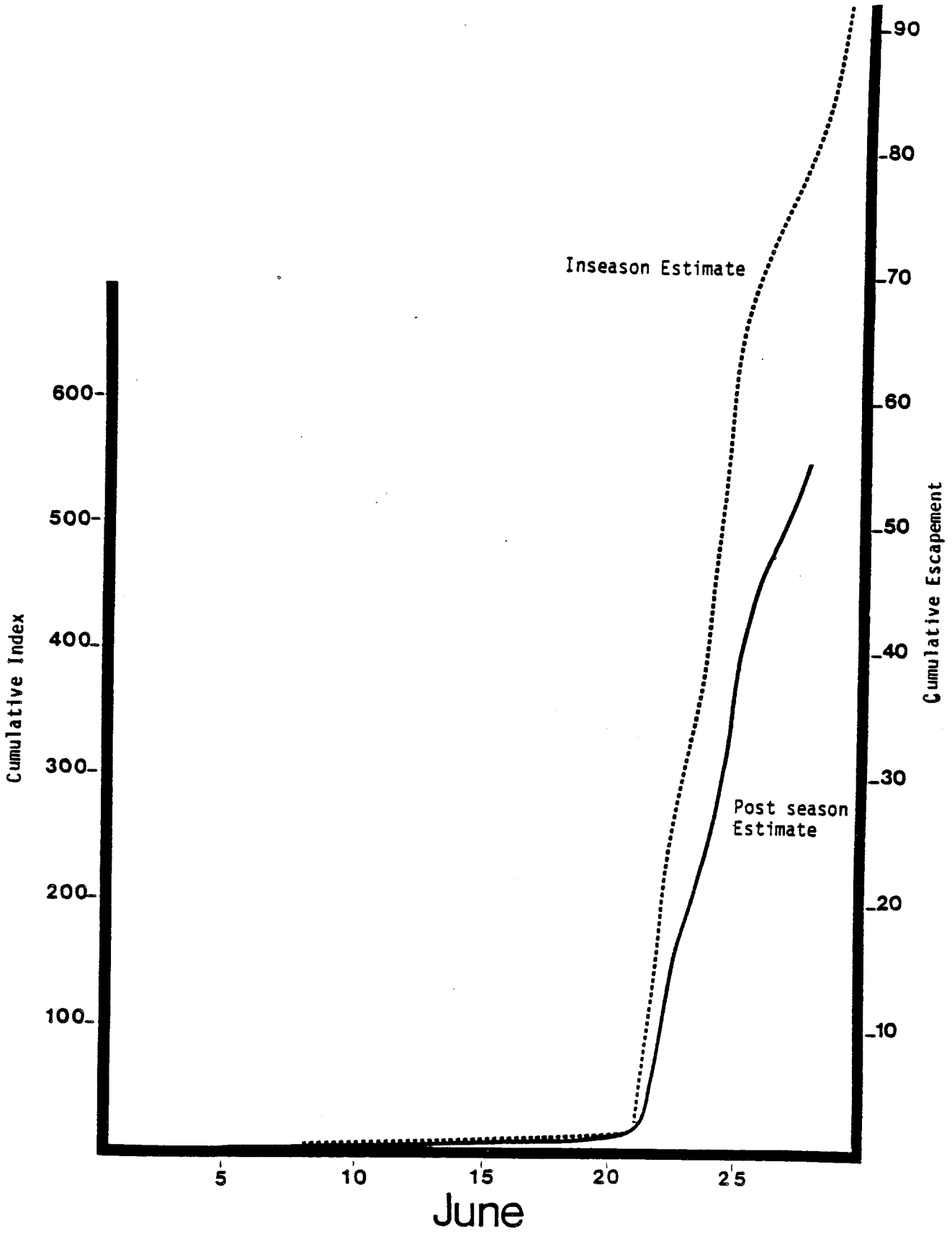

Figure 2. Cumulative chinook salmon index and estimated daily escapement from subsistence catches, Lewis Point, 1984.

Table 4. Mean length (mm), mean weight (kg), mean girth (mm), cumulative index points, estimated spawning escapement, and escapement per index point for chinook salmon migrating past Lewis Point, Nushagak River, 1982-1984.

Sampling Period	Length		Weight		Girth		Cumulative Index	Estimated Escapement[1]	Escapement per Index Point
	Mean (mm)	Number Sampled	Mean (kg)	Number Sampled	Mean (mm)	Number Sampled			
					1982				
6/2-6/25	788.99	100	8.74	18	515.61	98	318.09	61,740	194.10
					1983				
6/9-6/30	791.72	316	8.83	256	541.36	316	617.07	31,154	50.49
					1984				
6/5-6/28	758.30	384	7.65	92	491.39	33	578.52	55,142	95.32

[1] Estimate is the proportion of chinook salmon past Lewis Point during dates of operation based upon CPUE drift gillnet data at Portage Creek and total estimated escapement from aerial surveys.

Table 5. Age, length (mid-eye to tail fork, mm) and weight (round weight, kg) statistics for chinook salmon caught by subsistence users at Lewis Point, Nushagak River, 1984.

	Age Group					
	3 2	4 2	5 2	6 2	7 2	Total
Males						
Percent	0.61	11.52	31.81	13.34	2.73	60.00
Mean length	386.33	518.95	711.72	812.95	917.33	703.25
Std. error	16.00	7.78	7.38	11.00	23.27	4.97
Sample size	2	38	105	44	9	198
Mean weight	1.13	2.28	6.04	9.61	13.79	6.41
Std. error		0.32	0.60	0.94	0.00	0.39
Sample size	1	13	33	13	1	61
Females						
Percent	0.00	0.00	9.09	24.55	6.36	40.00
Mean lengt			784.63	842.51	914.95	840.88
Std. error			7.43	4.19	11.50	3.58
Sample size	0	0	30	81	21	132
Mean weight			7.53	9.25	13.32	9.51
Std. error			0.83	1.25	1.89	0.83
Sample size	0	0	9	19	3	31
Both Sexes						
Percent	0.61	11.52	40.90	37.88	9.09	100.00
Mean length	386.00	518.95	727.93	832.10	915.66	758.30
Std. error	16.00	7.78	5.97	4.73	10.66	3.31
Sample size	2	38	135	125	30	330
Mean weight	1.13	2.28	6.37	9.38	13.46	7.65
Std. error		0.32	0.50	0.84	1.42	0.38
Sample size	1	13	42	32	4	92

Age 5_2 (80%) sockeye salmon were most abundant within catches (Table 6). Average length and weight of sockeye salmon sampled were 562.52 mm and 3.07 kg, respectively.

Climatological and Hydrological Observations

Weather observations were recorded from 6 June until 27 June. Mean air and water temperatures were 11.0°C and 13.7°C, respectively (Table 7). Average precipitation was 3.3 mm per day.

Table 6. Age, length (mid-eye to tail fork, mm) and weight (round weight, kg) statistics for sockeye salmon caught by subsistence users at Lewis Point, Nushagak River, 1984.

	Age Group				
	4 2	5 2	6 2	6 3	Total
Males					
Percent	3.50	37.10	1.10	7.10	48.80
Mean length	505.00	576.87	615.00	585.17	573.78
Std. error	5.03	7.43		9.98	5.82
Sample size	3	31	1	6	41
Mean weight		3.55		3.62	3.56
Std. error		0.62		0.59	0.46
Sample size	0	6	0	3	9
Females					
Percent	2.30	43.00	0.00	5.90	51.20
Mean length	534.50	552.17		555.80	551.79
Std. error	20.50	2.24		9.44	2.37
Sample size	2	36	0	5	43
Mean weight		2.55		3.10	2.62
Std. error		0.16		0.66	0.24
Sample size	0	6	0	3	9
Both Sexes					
Percent	5.80	80.10	1.10	13.00	100.00
Mean length	516.70	563.61	615.00	571.84	562.52
Std. error	8.74	3.64		6.93	3.09
Sample size	5	67	1	11	84
Mean weight		3.02		3.38	3.07
Std. error		0.32		0.44	0.26
Sample size	0	12	0	6	18

Table 7. Climatological and hydrological observations at Lewis Point, Nushagak River, 1984.

Date	Sky[1] 0800	Sky[1] 2000	Precip. (mm)	Wind Speed (km/h)	Wind Dir.	Mean Temp. (C) Air	Mean Temp. (C) Water	Water Turbidity
6/ 6	5	3	0.00	17-25	W	8.1	12.7	Brown
7	5	2	0.00	8-25	SE	9.4	12.7	Brown
8	5	3	0.00	0		10.0	13.3	Brown
9	4	3	2.79	3- 8	SW	9.4	13.3	Lt. Brown
10	3	3	6.09	0		10.8	13.3	Brown
11	5	2	0.00	25-33	SW	10.8	13.3	Lt. Brown
12	3	3	0.00	3- 8	S	11.4	14.3	Brown
13	4	2	0.76	8-17	N	10.5	13.8	Dk. Brown
14	2	3	0.51	8	W	13.8	14.4	Dk. Brown
15	5	1	22.84	3-12	SW	12.2	15.5	Dk. Brown
16	1	3	0.00	25	SE	13.3	15.5	Brown
17	4	5	10.15	5- 8	E	10.0	14.4	Brown
18	4	3	4.06	3-17	ESE	11.4	14.2	Brown
19	3	3	10.41	3	N	11.9	14.4	Brown
20	5	3	1.78	17	W	11.9	14.2	Lt. Brown
21	3	1	0.00	8-17	SW	11.3	14.4	Lt. Brown
22	5	4	0.00	12	S	9.7	14.2	Lt. Brown
23	4	4	6.85	8-25	E	10.5	13.1	Brown
24	4	4	5.33	8-42	NE	10.5	12.5	Brown
25	4	4	2.79	33	NE	10.3	12.2	Dk. Brown
26	3	3	0.00	0		12.0	12.7	Brown
26	3	4	0.00	25	SE	11.7	13.7	Brown
Grand Means			3.30			11.0	13.7	

[1] Sky codes: 0 = No observation
1 = Cloud cover not greater than 10% (clear)
2 = Cloud cover not greater than 50%
3 = Cloud cover greater than 50%, but less than 100%
4 = Cloud cover 100% (completely overcast)
5 = Fog or thick haze

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