FRI-UW-9314
October 1993

FORECASTS OF THE 1994 SOCKEYE SALMON RUNS TO BRISTOL BAY

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A REPORT TO THE
PACIFIC SEAFOOD PROCESSORS ASSOCIATION

ACKNOWLEDGMENTS

A special thanks to Mrs. Bev Cross and Mr. Drew Crawford (ADF&G, Anchorage) for providing preliminary statistics that they and their staff collected from the 1993 run. Without these data a forecast could not have been made at this time.

KEY WORDS

Alaska, Bristol Bay fishery, forecasts, Port Moller, sockeye salmon, fish size

INTRODUCTION

Salmon runs are characterized by large year-to-year variation in number, most of which is expressed in the annual catches because escapement requirements that are nearly constant from year to year have priority. During the past 20 years, the largest annual catches of sockeye salmon (*Oncorhynchus nerka*) in the major Alaskan fisheries have all been more than ten times greater than the smallest catch (Fig. 1). In the Bristol Bay sockeye fisheries (the largest in the world), the extreme of variation occurred when the catch went from less than one million fish in 1973 to nearly 40 million fish just 10 years later. This year-to-year variation poses problems for the fishing industry when trying to prepare for the harvesting, processing, transportation, and sale of the salmon with a great deal of uncertainty. An accurate forecast of the catches can solve many of these problems and greatly assist fishery managers in the regulation of fishing early in the run. For the industry a forecast is most useful when available well in advance of the run (i.e., 6 months or more).

Sockeye salmon forecasts mostly depend on relationships between numbers of fish in a run and estimates of the numbers of fish at earlier times in their life (e.g., the approaching run, immature fish at sea, seaward migrant smolt, fry in lakes or number, of parent spawners [escapement]). In addition or sometimes as a substitute, characteristics of the salmon (body size, age, sex) or the salmon's environment (temperature) may be used if the measurement explains some of the variation in past runs. The accuracy of a Bristol Bay forecast is largely dependent on (1) how far in advance the forecast is made, (2) the accuracy of the estimates of fish numbers or substitute measures, and (3) the forecaster's experience and methods used.

Measurements needed to forecast the Bristol Bay sockeye salmon runs were not made routinely until about 1950; the first forecasts were made by biologists from the Fisheries Research Institute (FRI) and from what is now the National Marine Fisheries Service (NMFS) late in that decade. About 1962, the Alaska Department of Fish and Game (ADF&G) assembled a staff of biologists to make annual forecasts of the runs from inshore observations (escapements, smolt, age, etc.), and FRI made an annual forecast of the total Bristol Bay run from catches of immature salmon south of Adak Island (high seas forecast). I began forecasting in 1967 (1968 run) utilizing the catch-per-set data from the Adak research (FRI high seas project) but at a standardized set of stations. These forecasts were reasonably accurate until 1979, when only an average run was predicted but a very large run occurred, and this caught some processors shorthanded (Fig. 2). The FRI Adak research ended in 1978 (for other reasons), but I resumed forecasting in 1984 (1985 run) at the request of some Bristol Bay processors who wanted a second pre-season forecast to the forecasts made by ADF&G. This report presents a review of the 1993 season and forecasts of the 1994 sockeye salmon runs to Bristol Bay, which are based mostly on statistics provided by ADF&G.

REVIEW OF THE 1993 RUN

FORECASTS AND ACTUAL RUNS

The FRI prediction of total run to Bristol Bay in 1993 was 43 million with a 32 million catch, and the ADF&G predictions were nearly the same at 42 and 32 million (Table 1). The ADF&G forecasts resulting from their statistical analyses were increased by about 36% to adjust for a recent tendency to underforecast the runs (Geiger and Savikko 1993). Therefore, their database for the 1993 forecast actually indicated a lower run than forecast by FRI. The 1993 run and catch were higher than both forecasts (52 and 41 million) and the main cause was an unexpected record run to Egegik (23 million) and larger than normal returns of the older age groups, especially age 2.3 to Egegik, Naknek, and Ugashik.

The catch of 40.8 million was 28% greater than we predicted and a record for Bristol Bay. For the past 8 years, the catches have differed from our forecasts by an average of 31% (range: 5% to 75%) and from the ADF&G forecasts by an average of 42% (range: 14% to 126%). Therefore, both forecasts were relatively accurate in predicting a large catch in 1993.

In addition to the pre-season forecasts, we have made in-season forecasts each year since 1987 from a test-fishing program based out of Port Moller. This project, which was originally operated by ADF&G (1968-1985), has provided more accurate predictions than pre-season forecasts because we are estimating the relative abundance of the run just 6-8 days before arrival in the fishing districts. Prior to the 1993 season, a Bristol Bay almanac was provided to processors so they could make daily forecasts of the final 1993 run beginning June 20. The forecast method was based on the past cumulative Port Moller indices and the past runs, and assumed average run timing. Very early in 1993 (about June 14), the test boat catches indicated that the run was going to be much earlier than average and some adjustment in the forecast method would be necessary. The past method (from the almanac) tended to over-forecast whereas my adjustment for early timing tended to under-forecast the final run (Table 2). The Port Moller samples also provided a more accurate estimate of the age composition in the 1993 run than the pre-season forecasts or the False Pass catches (Table 3). The unusually high percentage of age 2.3 fish in the Port Moller catches correctly indicated that a large proportion of the 1993 run was bound for Egegik, where this age group was most abundant.

The fish arrived about 5 days early at Port Moller in 1993 and appeared to take less time than usual to reach the fishing districts (about 5 days). There was an early spring in Bristol Bay in 1993, but water temperatures off Port Moller were only a little above average. It turned out that temperatures in the North Pacific were unusually warm in June and July and probably caused the early arrival of the run, but this was not known in-season. From a post-season analysis, the 1993 run was about 3 days earlier than the average timing for our forecast database (1985, 1987–1992). One puzzling aspect of the sockeye salmon caught off Port Moller in 1993 was their large size (by age and sex). The index catches correctly predicted that a large run was coming, but large runs had typically contained smaller than average fish as a result of competition for food.

THE FISHERIES

The Port Moller program indicated that the 1993 run was going to be early, and management responded by providing more early (June 21-25) fishing time than usual (Table 4). By June 26, it was obvious that Egegik was going to have another very large run, and it was mainly a question of how large and where the rest of the fish were going. In June, drift gear was concentrated in Egegik and daily catches of 1 million were common. On July 2, fishing was opened in the Naknek/Kvichak and Nushagak districts as well, and there was a remarkable record daily catch of 5.3 million sockeye. Management of the 1993 fisheries by ADF&G was outstanding. Although there was some excess escapement in four rivers, with the exception of the small Igushik system, none of the escapements were so large as to pose any problem for future production. The Kvichak River had an escapement of 4 million, which was below the 1993 goal of 5 million, but still within the management range of 4 to 10 million. Egegik received an escapement of 1.5 million (only 27% above the upper goal) which was remarkable considering the size of the record run of 23 million.

The timing of the 1993 fisheries was early corresponding to the early run timing (Tables 5 and 6). This early fishing made it possible to harvest 78% of the near-record Bristol Bay run of 52 million and set an all-time record catch of nearly 41 million sockeye salmon.

FISH SIZE

The sockeye salmon caught in Bristol Bay in 1993 averaged 6 lb and were unexpectedly large by age and sex considering the magnitude of the run (Table 7). However, the body size of a Bristol Bay sockeye is also influenced indirectly by water temperature and the length of time the fish has to grow in the spring of the year it returns. Winter and spring weather over southwest Alaska has been relatively mild since 1976 (Fig. 3), and the spring nearshore surface temperatures in the Gulf of Alaska have also been warmer than average (Fig. 4). The warm temperatures in the spring of 1993 probably caused the increase in the size of sockeye as well as the early timing of the run. The 2-ocean fish showed the greatest increase in size in 1993 whereas the 3-ocean fish, although larger than the past 2 years, were still smaller than average (Figs. 5 and 6).

FORECASTS FOR 1994

The statistics used to forecast the 1994 Bristol Bay sockeye salmon runs came from several sources: (1) the numbers, ages, lengths, and weights of adult salmon in the catches and escapements and smolt in the seaward migrations were from annual reports by ADF&G (e.g., Stratton and Crawford [1992] and Woolington et al. [1991]); (2) the relative numbers, ages, and lengths of fry in the Wood River and Kvichak lake systems were from annual reports by FRI (e.g., Rogers et al. [1992]); (3) air temperatures for Bristol Bay were from monthly reports by the U.S. Weather Bureau; and (4) coastal sea surface temperatures at Kodiak and Adak were from monthly reports of the National Oceanic and Atmospheric Administration. The Bristol Bay run

statistics used in forecasting do not include any estimates of interceptions (i.e., fish caught on the high seas or at False Pass). We are forecasting the inshore run from inshore statistics.

Run predictions were made for each major age group (usually 4) and summed to obtain a forecast for a river system. The river system forecasts were summed to predict the run to a fishing district, and the predicted catch was obtained by subtracting the average of escapements in recent years with runs comparable to the forecast. To predict the return of an age group in 1994, all relevant statistics from past brood years (since 1981) were assembled and submitted to a step-wise multiple regression procedure. When no measurement (variable) was significantly correlated with past variation in a run, then the average run was used to predict the 1994 run. Only adult returns since 1985 (1981 brood year) were used because there has been a recent shift in the ocean age composition towards more 3-ocean fish in the returns (Fig. 7) and a decrease in the relative production (return-per-spawner or escapement) for all systems except Egegik (Table 8). In contrast, the production of sockeye salmon at Egegik has increased greatly since 1980. Egegik used to be a low producer relative to the size of the lake (second largest in Bristol Bay). The recent production is more in line with the other systems. In addition, the more recent years are likely to better predict events in 1994 than earlier observations. An exception to this was in the forecasts of 2-ocean returns to the Kvichak (which has mainly 2-ocean fish). Here I used statistics starting with the 1974 brood year (1978 run).

The forecast of the total 1994 Bristol Bay sockeye salmon run is 48.8 million with a predicted catch of 34.1 million (Table 9). Over the past 4 years, there have been large runs of 3-ocean fish, especially relative to the returns of 2-ocean fish in the preceding years (Fig. 7 and Table 10). The 2-ocean fish were generally small for these 4 years, but that was not the case for the 1993 return, so we might expect a more typical return of 3-ocean fish in 1994.

The sockeye salmon runs and our forecasts, past and present, for the four major districts in Bristol Bay are shown in Figure 8 and the databases and forecast statistics are presented in Tables 11-16.

The Egegik, Ugashik, Nushagak, and Togiak are expected to have smaller runs in 1994 than the 1993 runs; however, the Naknek/Kvichak is expected to have a much larger run in 1994 as a result of a high forecast (19 million) for the Kvichak. About 50% of the total 1994 forecast of 48.8 million is contained in just two individual forecasts; the age 2.2 fish in the Kvichak (13 million) and the age 2.3 fish in Egegik (12 million). Because past runs have sometimes differed considerably from the pre-season forecasts, it will again be very important for the industry to have an accurate in-season forecast from the Port Moller test fishery (Fig. 9).

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Woolington, J.D., B.A. Cross and B.L. Stratton. 1991. Bristol Bay sockeye salmon smolt studies. ADF&G Tech. Fish. Rep. 91-19. 84 p.

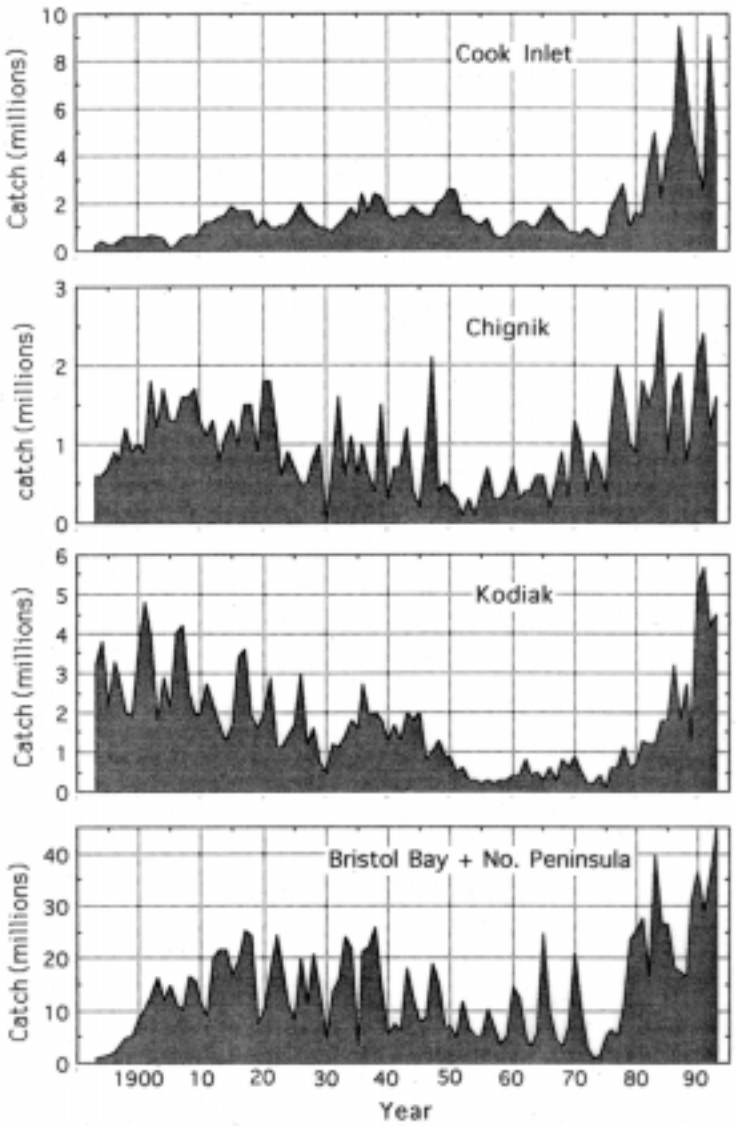

FIGURE 1. Annual commercial catches of sockeye salmon in the major Alaskan fisheries, 1893–1992.

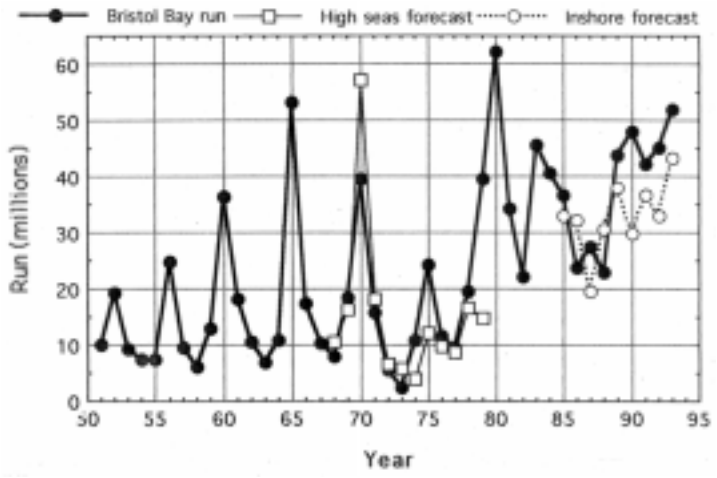

FIGURE 2. Annual runs of sockeye salmon to Bristol Bay, 1951–92, with pre-season forecasts from high seas sampling (1968–79) and inshore statistics (1985–94).

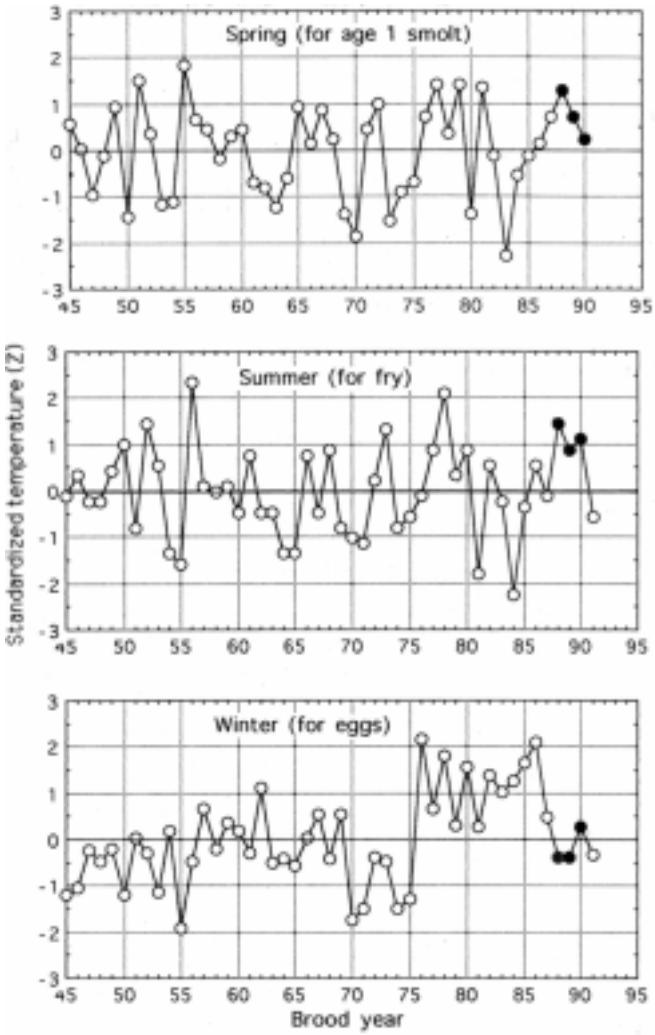

FIGURE 3. Relative air temperatures (number of standard deviations from the mean) in Bristol Bay (Dillingham and King salmon) for sockeye salmon brood years, 1945–91.

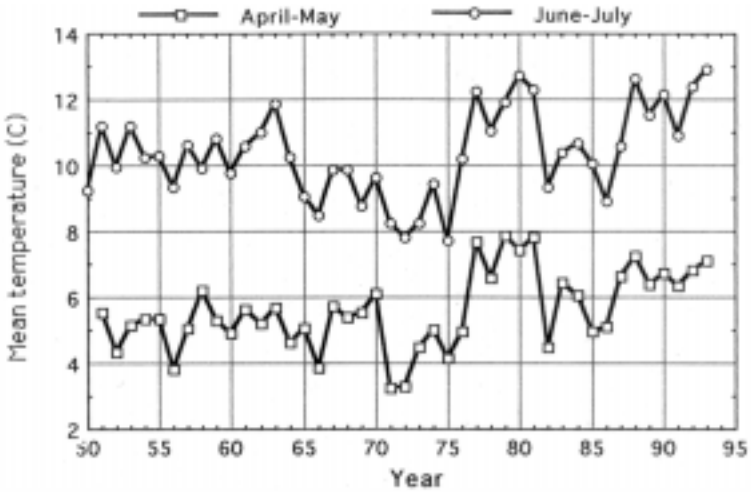

FIGURE 4. Average spring (April/May and June/July) sea surface temperatures at Kodiak (Gulf of Alaska), 1950–93.

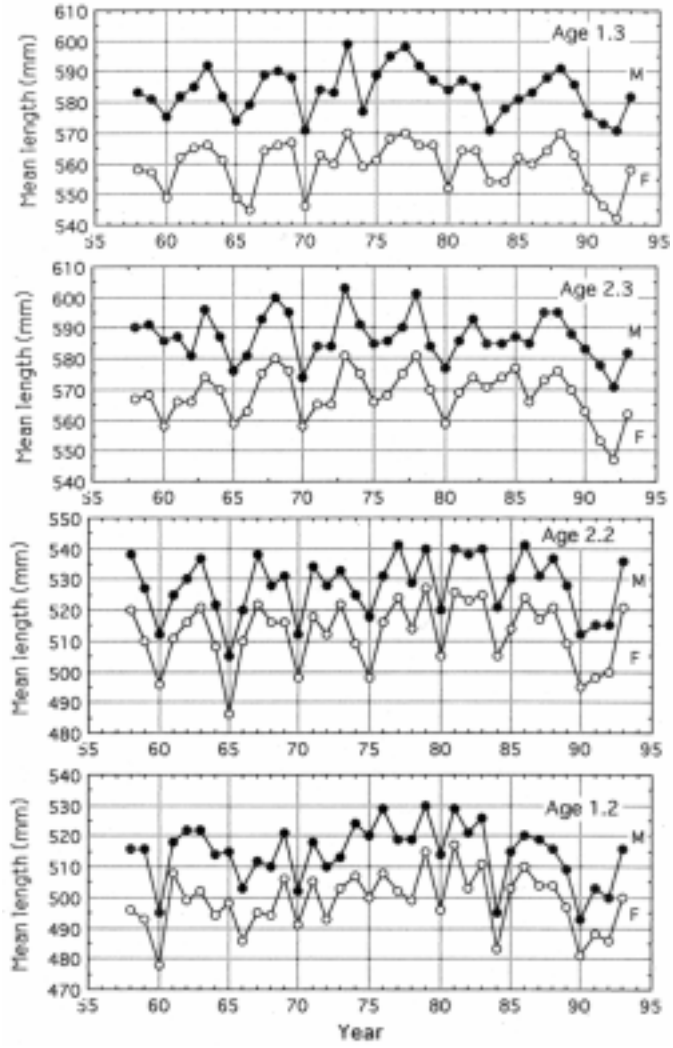

FIGURE 5. Annual commercial catches of sockeye salmon in the major Alaskan fisheries, 1893–1993.

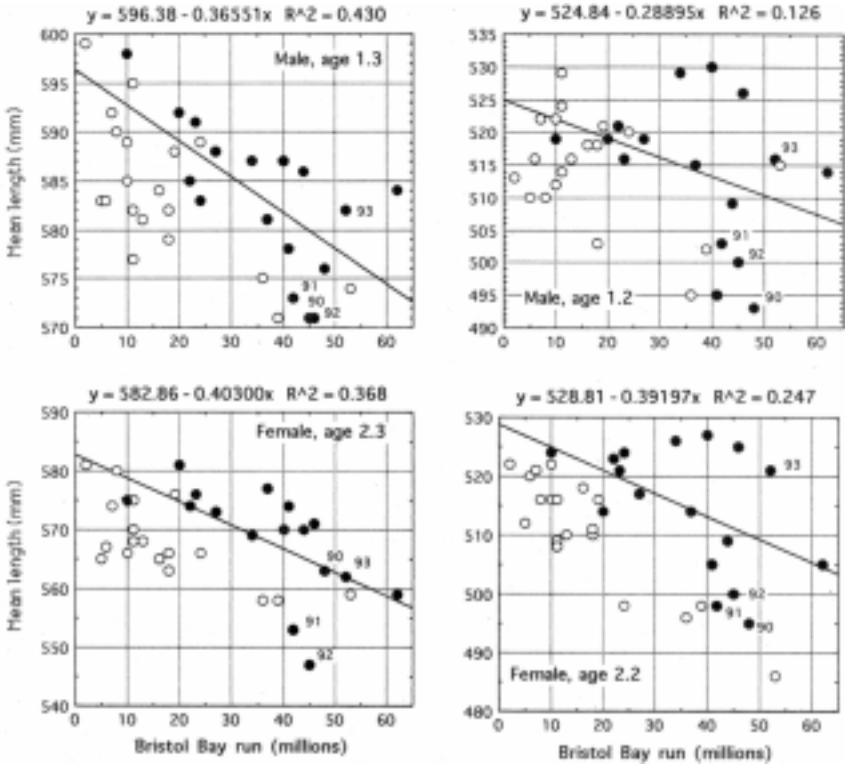

FIGURE 6. Regressions of mean length on number of sockeye salmon in the Bristol Bay run, 1977–1993 (open points for 1959–76).

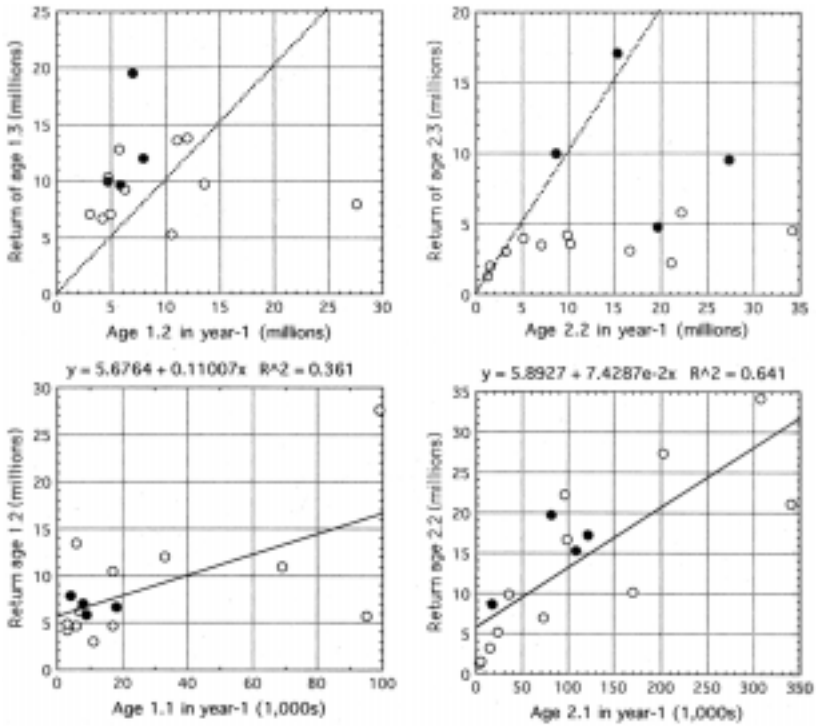

FIGURE 7. Plots of the runs by freshwater age of 2- and 3-ocean-aged sockeye salmon on the runs of 1- and 2-ocean-aged fish the previous year for the combined Bristol Bay runs, 1979–93 (solid points for the runs in 1990–93).

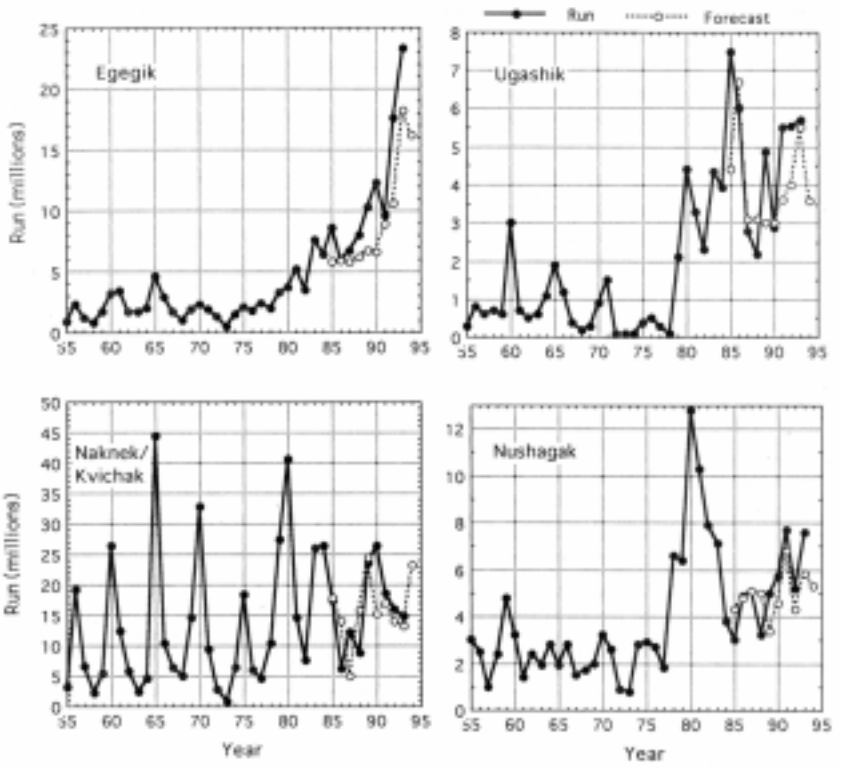

FIGURE 8. Sockeye salmon runs to the four major Bristol Bay fishing districts, 1955–93, and the FRI pre-season forecasts, 1985–94.

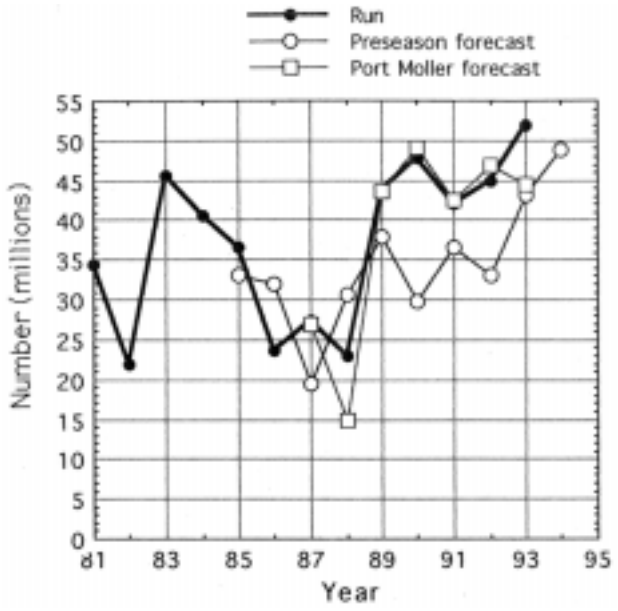

FIGURE 9. The annual Bristol Bay sockeye runs, 1981–93, the FRI pre-season forecasts, 1985–94 and the averages of the June 25 and June 30 in-season Port Moller forecasts, 1987–93.

Table 1. Forecasts and actual runs to Bristol Bay in 1993 (in millions).

	Forecasts					
	ADF&G		FRI		Actual	
District	Run	Catch	Run	Catch	Run	Catch
Naknek/Kvichak						
Kvichak	11.7		9.1		9.3	
Naknek	3.4		3.6		4.7	
Branch	0.4		0.4		0.8	
Subtotal	15.5	9.3	13.1	6.9	14.8	8.9
Egegik	15.8	14.8	18.2	16.2	23.3	21.8
Ugashik	4.9	4.2	5.5	4.5	5.7	4.3
Nushagak						
Wood	2.5		2.8		3.8	
Igushik	1.2		1.6		1.6	
Nush/Nuyakuk	1.4		1.6		2.2	
Subtotal	5.1	3.3	6.0	4.0	7.6	5.3
Togiak	0.5	0.4	0.5	0.3	0.7	0.5
Bristol Bay	41.8	32.0	43.3	31.9	52.1	40.8

Table 2. Summary of 1993 Bristol bay sockeye in-season forecasts from the Port Moller test boat.

Date	From almanac (no adjustment)	Rogers' adjusted for early timing Forecast	Date issued	Comment
June				
14			14th	Record daily and cumulative indices; predicted in Bay on 6/20–21
15			15th	Record index catches for this date
16			16th	same
17				Test boat blown out
18				same
19				
20	54			Egegik opening, catch of 540,000 a record for this early date
21	54			Egegik and Nak/Kvi openings, catch of 600,000
22	55	40-45	22nd	South Unimak catches indicate a 40+ million run
23	55			Cumulative BB catch of 2.8 million a record for this date
24	55			Run strong and early at Egegik
25	61	44	26th	Mostly 3-ocean fish at Moller; Unimak shifted to 2-ocean on 20th
26	65			Egegik catches very strong; Nak/Kvi & Nushagak only so so.
27	65			Escapement 4 days early for Wood, Naknek & Kvichak, but 7
28	62			days early at Egegik; fish lengths large for a 40+ million run
29	59	45	30th	Test boat blown out on the 26th & 27th
30	58	42	July 2nd	Projected catch of 32 million
1	57			Test boat blown out
2	59			A record single day BB catch (4.9 million) & large PM index
3	56	50+	3rd	2-ocean fish starting to show at Moller, may be average timing
4	54			
5	55			
6	52			

Final run = 52 Mid point in catch and C+E was July 2 (prior average was July 6-7)
Catch = 41 Run started and ended about five days earlier than average

Table 3. Comparison of the age compositions of sockeye salmon in Bristol Bay runs with age compositions in Port Moller catches, the False Pass fishery and pre-season forecasts.

Year		Age composition (%) 1.2	2.2	1.3	2.3	all .2	all .3	Forecast/run (millions)
1989	ADF&G	22	45	24	9	67	33	28.9
	FRI	13	62	18	7	75	25	38.0
	False Pass	8	62	13	15	70	28	
	Port Moller	13	45	22	17	58	39	37.0
	BB run	11	62	16	9	73	26	43.8
1990	ADF&G	19	42	26	13	61	39	25.4
	FRI	16	40	28	16	56	44	29.8
	False Pass	16	37	20	25	53	45	
	Port Moller	10	37	24	26	48	52	56.0
	BB run	14	41	21	20	56	43	47.8
1991	ADF&G	28	25	31	16	53	47	30.0
	FRI	41	14	31	14	55	45	36.7
	False Pass	21	33	36	6	54	46	
	Port Moller	12	14	55	13	28	71	37.0
	BB run	19	20	46	11	39	60	42.1
1992	ADF&G	19	39	27	13	58	42	37.1
	FRI	18	39	27	14	57	43	33.0
	False Pass	6	35	25	30	42	58	
	Port Moller	8	35	31	22	43	53	45.0
	BB run	13	34	27	22	47	50	44.9
1993	ADF&G	23	41	21	14	64	35	41.8
	FRI	16	41	20	21	56	43	43.3
	False Pass	14	46	14	23	61	38	
	Port Moller	7	27	19	44	34	65	45.0
	BB run	13	33	18	33	46	53	51.9

Forecasts and runs do not include jacks (ages 1.1 and 2.1).

The Port Moller forecast is on 6/30 and the age composition is through 6/30 only. In 1989 and 1993, the percentage of 2-ocean fish increased with date, whereas in 1990 the percentage of 2-ocean fish at Port Moller decreased with date.

Table 4. Fishing time in major Bristol Bay fishing districts; percent of the time (120 h) open to fishing by 5-day periods.

	Naknek/Kvichak								Egegik							
	21	26	1	6	11	16	6/26		21	26	1	6	11	16	6/26	
Year	-25	-30	-5	-10	-15	-20	7/15	Run	-25	-30	-5	-10	-15	-20	7/15	Run
81	72	43	60	67	100	100	68	14.6	80	63	62	100	100	100	81	5.1
82	92	100	100	100	100	60	100	7.5	82	63	30	92	100	100	71	3.5
83	48	38	100	88	100	80	82	26.1	48	60	100	100	100	88	90	7.5
84	48	20	47	74	82	100	56	26.5	48	40	22	46	100	100	52	6.4
85	40	33	68	47	34	10	46	17.4	28	41	20	72	85	88	55	8.6
86	7	0	52	46	87	51	46	6.3	0	9	30	31	77	67	37	6.0
87	20	8	8	52	100	60	42	12.2	0	29	19	29	28	46	26	6.7
88	48	8	28	10	59	100	26	8.8	48	20	18	26	42	88	27	8.0
89	48	18	55	79	78	100	58	23.6	15	20	17	76	92	100	51	10.3
90	11	17	57	79	100	100	63	27.7	8	8	29	67	39	96	36	12.4
91	8	8	100	85	95	68	72	18.6	9	9	70	38	63	88	45	9.6
92	20	25	35	86	70	100	54	15.9	17	25	47	33	70	62	44	17.6
93	70	90	100	100	70	100	75	14.8	33	57	50	43	42	93	48	23.3
Mean	39	27	55	66	80	82	56	17.6	30	34	38	57	70	84	50	10.2

	Nushagak								Ugashik							
	21	26	1	6	11	16	6/26		21	26	1	6	11	16	7/1-	
Year	-25	-30	-5	-10	-15	-20	7/15	Run	-25	-30	-5	-10	-15	-20	7/20	Run
81	68	81	68	100	100	100	87	10.3	80	63	93	100	100	100	98	3.4
82	57	100	100	100	100	100	100	7.9	63	63	52	100	100	100	88	2.3
83	20	20	55	100	100	100	69	7.0	39	39	53	44	100	88	71	4.3
84	20	31	20	42	100	100	48	3.8	41	41	31	32	71	92	57	3.9
85	0	10	20	34	100	88	41	3.0	41	41	39	83	52	88	66	7.5
86	0	10	27	37	100	100	44	4.9	0	0	29	23	77	68	49	6.0
87	0	15	40	65	92	60	53	5.1	20	0	20	20	10	47	24	2.8
88	0	15	11	0	77	67	26	3.2	48	0	9	10	31	11	15	2.2
89	0	20	60	100	100	100	70	5.0	48	0	41	72	67	100	70	4.9
90	0	0	22	100	100	100	56	5.0	20	0	10	21	31	76	35	2.9
91	6	20	100	100	100	100	80	7.7	7	0	16	46	92	100	64	5.5
92	5	26	28	45	100	80	50	5.2	20	17	0	20	32	100	38	5.5
93	14	48	100	100	100	100	87	7.6	40	10	20	90	100	60	67	5.7
Mean	12	25	41	66	97	90	57	5.5	36	19	31	47	61	75	54	4.5

Underlined numbers when entire district was not open (e.g. Naknek only or Igushik only).
Strikes in 1982 & 1991 negated early fishing time, i.e. prior to July 4.
Averages exclude 1982 and 1991.

Table 5. Timing of Nushagak and Naknek/Kvichak sockeye catches, 1958–1993.

	Nushagak					Naknek/Kvichak				
	Catch	Percentage through:				Catch	Percentage through:			
Year	(millions)	6/25	6/30	7/5	7/10	(millions)	6/25	6/30	7/5	7/10
1958	1.1	5	40	73	88	0.9	2	27	48	91
59	1.7	1	3	38	74	1.7	4	8	35	61
60	1.5	12	36	62	71	9.8	1	17	50	69
61	0.5	9	29	71	84	8.2	1	32	80	96
62	1.5	4	4	62	82	2.2	14	28	48	78
63	0.8	+	+	61	91	1.0	5	29	70	85
64	1.4	7	18	63	80	2.2	5	16	26	92
65	0.8	13	28	49	73	19.1	5	29	50	72
66	1.2	2	3	39	73	5.4	2	20	63	93
67	0.6	18	73	87	89	2.3	26	55	77	86
68	0.7	17	66	80	92	1.2	4	33	45	92
69	0.8	+	+	58	81	4.7	1	18	59	77
70	1.2	2	15	59	89	17.8	3	31	65	91
71	1.3	1	5	21	53	5.9	1	10	28	43
72	0.4	1	10	50	96	1.1	10	53	76	94
73	0.3	1	29	77	77	0.2	14	29	79	79
74	0.5	0	0	26	64	0.5	0	0	13	65
75	0.6	0	0	+	62	3.1	0	0	17	57
76	1.2	2	8	49	68	2.5	0	8	40	62
77	0.6	3	21	66	79	2.2	1	23	76	84
78	3.1	5	21	62	92	5.1	2	26	26	82
79	3.3	7	40	63	82	15.0	7	32	63	84
80	4.5	0	0	28	72	15.1	1	3	33	71
81	7.5	5	18	49	83	11.0	5	22	60	86
82	5.9	1	19	54	86	5.0	2	19	45	86
83	5.1	1	18	53	78	21.6	2	25	58	82
84	2.2	11	24	51	78	14.2	3	11	38	75
85	1.3	+	21	48	86	8.1	2	37	68	82
86	2.8	+	8	33	68	2.9	1	1	36	52
87	3.3	6	15	32	73	4.9	1	3	6	27
88	1.7	0	16	58	58	3.6	7	18	52	56
89	2.9	0	16	59	80	13.9	7	25	57	80
90	3.3	0	0	17	65	17.4	1	11	46	70
91	5.3	0	1	38	77	10.6	1	4	44	76
92	2.9	1	15	39	61	9.3	2	10	38	72
93	5.3	5	29	67	91	8.9	12	40	78	94
Average (1981-93)	3.8 #	3	15	46	76	10.1	4	17	48	72

+ = less than 1%

Table 6. Timing of Egegik and Ugashik sockeye catches, 1958–93.

	Egegik					Ugashik				
	Catch	Percentage through:				Catch	Percentage through:			
Year	(millions)	6/25	6/30	7/5	7/10	(millions)	6/25	6/30	7/5	7/10
1958	0.5	3	19	72	92	0.4	5	32	58	89
59	0.7	7	17	37	66	0.4	5	12	28	65
60	1.4	8	22	42	68	0.8	3	13	31	63
61	2.7	14	33	58	96	0.4	5	11	40	77
62	0.6	10	26	67	88	0.2	7	7	26	72
63	0.7	5	14	44	81	0.2	6	25	51	72
64	1.1	11	28	33	85	0.6	6	10	20	66
65	3.2	7	42	68	88	0.9	3	23	48	83
66	2.1	8	17	68	96	0.4	3	9	32	78
67	1.1	37	84	95	95	0.2	32	52	65	82
68	0.7	18	72	99	99	0.1	6	34	56	83
69	0.9	10	41	72	99	0.2	2	6	82	91
70	1.4	23	37	76	95	0.2	7	29	29	56
71	1.3	6	17	34	76	1.0	+	2	12	50
72	0.8	9	25	82	100	+	…	…	…	…
73	0.2	12	56	96	96	+	…	…	…	…
74	0.2	2	2	42	94	+	…	…	…	…
75	1.0	+	2	18	94	+	…	…	…	…
76	1.3	2	12	62	93	0.2	2	5	18	60
77	1.8	7	30	62	86	0.1	28	28	28	28
78	1.2	13	30	30	71	+	…	…	…	…
79	2.3	16	38	71	85	0.4	2	8	18	22
80	2.6	2	10	41	74	0.9	+	3	8	33
81	4.4	12	34	64	89	2.1	2	7	19	55
82	2.4	11	28	33	87	1.1	2	11	25	74
83	6.8	3	28	58	84	3.3	1	10	30	58
84	6.3	7	34	49	75	2.7	2	10	27	44
85	7.5	6	44	59	86	6.3	1	13	31	65
86	5.0	2	6	43	63	4.9	2	2	29	54
87	5.4	3	34	58	80	2.1	3	3	30	56
88	6.4	18	41	63	80	1.5	4	4	7	21
89	8.7	8	28	51	73	3.2	2	2	8	43
90	10.0	1	4	36	74	2.1	2	2	12	47
91	6.8	+	4	49	75	3.0	1	1	10	54
92	15.7	7	18	49	78	3.4	1	3	3	21
93	21.8	17	42	78	95	4.3	3	5	19	75
Average (1981-93)	8.2	8	27	53	80	3.1	2	6	19	51

Table 7. Average weights of sockeye (lb) in the Bristol Bay commercial catches, 1960–93.

	2-ocean			3-ocean			All	All	All	BB Catch	Percent	Percent
Year	Male	Female	Combined	Male	Female	Combined	males	females	fish	millions	3-ocean	females
1960	4.7	4.0	4.4	7.2	6.0	6.5	4.9	4.7	4.8	14	20	38
61	5.4	4.7	5.2	7.4	6.2	6.8	6.7	5.9	6.3	12	71	49
62	5.6	4.8	5.2	7.4	6.3	6.8	6.0	5.3	5.7	5	27	50
63	5.7	4.9	5.3	7.9	6.5	7.1	6.6	5.5	6.0	3	51	54
64	5.4	4.7	5.1	7.7	6.5	7.0	5.8	5.3	5.6	6	27	47
65	4.7	4.2	4.5	6.9	5.9	6.3	4.9	4.5	4.7	24	11	40
66	5.1	4.7	4.9	7.5	6.3	6.7	6.9	6.0	6.3	9	80	62
67	5.6	4.9	5.2	7.7	6.5	6.9	6.3	5.6	5.9	4	39	56
68	5.4	4.8	5.1	8.0	6.7	7.2	6.4	5.8	6.1	3	47	53
69	5.5	4.9	5.2	7.4	6.4	6.9	5.7	5.2	5.4	7	15	52
70	5.0	4.5	4.8	6.7	5.7	6.0	5.2	4.7	5.0	21	10	47
71	5.3	4.7	4.9	7.2	6.0	6.5	6.4	5.5	5.9	10	62	60
72	5.4	4.7	5.1	7.6	6.3	6.9	6.6	5.8	6.2	2	60	48
73	5.5	5.1	5.3	8.4	6.8	7.5	7.9	6.6	7.2	1	86	53
74	5.5	4.9	5.2	7.5	6.6	7.1	6.0	5.4	5.7	1	27	52
75	5.4	4.7	5.1	7.7	6.4	6.9	6.0	5.4	5.7	5	32	49
76	5.7	4.9	5.4	8.0	6.7	7.2	6.4	5.8	6.1	6	40	47
77	5.5	4.9	5.2	8.3	6.8	7.5	7.0	6.2	6.6	5	60	53
78	5.4	4.7	5.1	8.2	6.6	7.3	6.5	5.6	6.1	10	44	48
79	5.8	5.2	5.5	7.4	6.3	6.8	6.1	5.5	5.8	21	20	50
80	5.2	4.6	4.9	7.4	6.0	6.6	5.8	5.0	5.4	24	29	51
81	5.7	5.0	5.3	7.6	6.4	7.0	6.7	5.7	6.2	26	53	52
82	5.3	4.8	5.0	7.5	6.4	6.9	7.0	6.0	6.5	15	77	50
83	5.7	4.8	5.2	7.1	6.2	6.6	5.9	5.1	5.5	37	18	52
84	5.1	4.5	4.9	7.2	6.3	6.7	5.8	5.2	5.5	25	35	46
85	5.4	4.7	5.1	7.3	6.4	6.8	6.2	5.5	5.8	24	44	48
86	5.7	4.9	5.3	7.4	6.2	6.7	6.6	5.7	6.1	16	57	54
87	5.3	4.8	5.0	7.5	6.5	6.9	6.3	5.7	6.0	16	49	53
88	5.4	4.7	5.1	7.6	6.6	7.1	6.7	5.9	6.3	14	60	47
89	5.3	4.6	4.9	7.4	6.2	6.8	6.0	5.0	5.5	28	29	53
90	5.0	4.6	4.8	7.4	6.2	6.7	6.1	5.4	5.8	33	50	53
91	5.1	4.3	4.7	7.2	5.9	6.5	6.5	5.4	5.9	26	67	54
92	4.8	4.3	4.6	6.7	5.7	6.1	5.8	5.1	5.5	32	58	45
93	5.5	4.7	5.1	7.3	6.2	6.7	6.4	5.6	6.0	41	54	53
Means												
84-93	5.3	4.6	4.9	7.3	6.2	6.7	6.2	5.4	5.8	26	50	51

Table 8. Averages of escapements and returns of sockeye salmon per unit (km^2) of lake surface area.

River system	No. of lakes	Surface area (km^2)	1952-73 averages Escape. (1000s/km^2)	Return	R/E	1974-80 averages Escape (1000s/km^2)	Return	R/E	1981-87 averages Escape. (1,000s/km^2)	Return	R/E
Kvichak	2	2889	1.6	3.0	2.3	2.7	6.5	3.0	1.6	3.6	2.3
Egegik	1	1132	0.7	1.8	2.8	0.8	4.3	6.1	0.9	10.2	10.9
Naknek	4	791	1.0	2.3	3.1	1.8	5.4	3.3	1.8	6.8	2.5
Wood	5	425	1.9	3.4	2.1	3.8	8.9	2.3	2.6	5.6	2.3
Ugashik	2	385	1.3	1.9	1.7	2.3	9.9	11.5	2.8	11.9	4.6
Nush/Nuyakuk	3	280*	0.6	1.7	3.7	3.3	7.9	3.9	2.3	5.0	2.4
Igushik	2	74	3.2	5.9	3.1	8.2	21.1	7.5	4.0	14.8	4.3
Togiak	3	49**	2.4	5.6	2.6	4.9	14.7	4.1	4.6	11.7	2.6

* Does not include rearing areas of the Nushagak and Mulchatna Rivers and small lakes.
** Does not include rearing areas of Togiak River tributaries and small lakes.

Table 9. Forecasts of the 1994 Bristol Bay sockeye runs.

River System	District	Runs by age group (millions) 1.2	2.2	2-ocean	0.3	1.3	2.3	3-ocean	Total	Catch
Kvichak		3.8	12.8	16.6		1.4	0.8	2.1	18.7	
Naknek		1.4	0.5	1.9		0.7	1.3	2.0	3.9	
Branch		0.2	0.1	0.3		0.2	+	0.2	0.5	
	Naknek/Kvichak	5.4	13.4	18.8		2.3	2.1	4.3	23.1	13.1
	Egegik	0.4	2.9	3.3		1.2	11.7	12.9	16.2	14.2
	Ugashik	0.6	1.7	2.3		0.9	0.4	1.3	3.6	2.9
Wood		1.5	0.1	1.6		1.4	+	1.4	3.0	
Igushik		0.3	0.1	0.4		0.4	+	0.4	0.8	
Nush/Nuy		0.1	+	0.1	0.4	0.8	+	1.2	1.5 *	
	Nushagak	1.9	0.2	2.1	0.4	2.6	+	3.0	5.3	3.5
	Togiak	0.1	+	0.1		0.4	0.1	0.5	0.6	0.4
	Bristol Bay	8.4	18.2	26.6	0.4	7.4	14.3	22.0	48.8	34.1

A + indicates less than 100,000 predicted.

* the Nushagak/Nuyakuk forecast includes 0.2 million 4-ocean fish.

Table 10. Bristol Bay sockeye runs (millions) by age group, 1958–1993 and forecasts for 1994.

Year	1-ocean	Age 1.2	Age 2.2	Total 2-ocean	Age 1.3	Age 2.3	Total 3-ocean	4-ocean	Total	Catch
58		1.5	1.5	3.0	1.4	1.3	2.7		5.7	3
59		4.8	5.8	10.9	1.0	0.9	1.9		12.8	5
60		30.0	2.0	32.0	2.8	1.5	4.3		36.4	14
61	+	0.4	5.6	6.1	10.9	1.0	12.0	+	18.1	12
62	+	2.4	4.8	7.3	1.0	2.1	3.1	+	10.4	5
63	+	1.9	1.9	3.9	1.1	1.7	2.9	+	6.9	3
64	0.2	5.6	2.8	8.4	1.5	0.7	2.3	+	10.9	6
65	+	1.2	47.6	48.9	3.1	1.1	4.2	+	53.1	24
66	+	1.3	3.0	4.4	3.5	9.6	13.1	+	17.5	9
67	+	1.1	5.7	6.8	1.3	2.0	3.5	+	10.3	4
68	0.2	3.1	1.9	5.0	1.7	1.1	2.8	+	8.0	3
69	0.6	10.8	5.3	16.2	1.2	1.0	2.2	+	19.0	7
70	+	3.4	32.2	35.6	2.7	1.0	3.7	0.0	39.4	21
71	+	1.6	4.8	6.4	6.8	2.6	9.4	+	15.8	10
72	+	1.0	1.7	2.7	1.2	1.4	2.7	+	5.4	2
73	+	0.2	0.2	0.4	1.0	0.9	2.0	+	2.4	1
74	0.1	2.0	6.8	8.8	1.4	0.6	2.0	+	10.9	1
75	+	1.6	17.2	19.1	2.3	2.7	5.1	+	24.2	5
76	+	1.6	5.3	7.3	2.6	1.5	4.2	+	11.5	6
77	+	1.6	2.8	4.5	1.8	3.2	5.1	+	9.6	5
78	0.4	10.5	1.5	12.0	4.9	2.3	7.2	0.2	19.8	10
79	0.3	11.0	21.1	32.2	5.3	2.0	7.3	+	39.8	22
80	0.3	12.0	34.1	46.2	13.6	2.2	15.9	+	62.4	24
81	+	5.7	10.2	15.9	13.8	4.5	18.4	+	34.3	26
82	0.1	4.2	1.2	5.4	12.8	3.6	16.4	0.2	22.1	15
83	0.1	27.6	9.8	37.4	6.6	1.3	7.9	0.3	45.7	37
84	0.1	6.2	22.2	28.4	7.9	4.2	12.2	+	40.7	25
85	0.1	4.7	16.7	21.4	9.2	5.8	15.0	+	36.6	24
86	+	3.0	7.0	10.0	10.1	3.1	13.5	0.1	23.6	16
87	+	13.5	3.2	16.7	7.0	3.5	10.5	+	27.3	16
88	0.2	4.9	5.1	10.0	9.7	3.0	12.7	0.2	23.2	14
89	0.1	4.7	27.3	32.1	7.0	4.0	11.6	0.1	43.9	29
90	+	7.0	19.7	27.0	9.9	9.5	20.6	0.2	47.8	33
91	0.1	7.9	8.6	16.6	19.5	4.8	25.4	0.1	42.2	26
92	0.1	5.8	15.3	21.3	12.0	10.0	22.5	1.1	45.0	32
93	0.2	6.7	17.2	24.0	9.6	17.1	27.3	0.6	52.1	41
94		**8.4**	**18.2**	**26.6**	**7.4**	**14.3**	**22.0**	**0.2**	**48.8**	**34**
Means 1984-93	0.1	6.4	14.2	20.8	10.2	6.5	17.1	0.2	38.2	26

Table 11. Kvichak sockeye salmon statistics to forecast 1994 runs by freshwater age.

Brood year	Escapement Number millions	Escapement Percent age .2	Age 1 smolt Number millions	Age 1 smolt Mean weight	Adult Return (millions) 1.1	1.2	1.3	Total	Smolt/ adult survival (%)	Mean length age 1.2
74	4.43	91	108	5.8	.009	6.14	1.93	8.08	7.5	501
75	13.14	96	78	5.5	.005	5.50	1.18	6.69	8.6	517
76	1.97	81	32	6.0	.005	5.04	.76	5.81	18.1	500
77	1.34	86	29	6.0	.039	1.82	.84	2.70	9.3	518
78	4.15	81	182	5.9	.000	1.66	1.09	2.75	1.5	513
79	11.22	90	220	5.4	.057	17.60	2.14	19.80	9.0	510
80	17.50	96	150	5.1	.002	2.81	1.49	4.30	2.9	478
81	1.75	82	7	4.9	.000	.77	.22	.99	14.1	523
82	1.14	65	52	6.8	.000	.44	.52	.96	1.8	528
83	3.57	93	24	5.3	.001	8.38	2.98	11.36	47.3	515
84	10.49	80	83	5.5	.000	2.46	1.87	4.33	5.2	512
85	7.21	68	11	4.5	.007	1.00	1.24	2.25	20.4	505
86	1.18	74	13	5.6	.000	.66	1.05	1.71	13.2	490
87	6.07	96	147	5.5	.004	4.04	2.38	6.42	4.4	493
88	4.06	56	47	5.8	.004	2.43	2.37	4.80	10.2	495
89	8.32	90	87	5.5	.002	2.01	**1.38**			511
90	7.00	90	18	5.4	.008	**3.85**				

1) 94 forecast of age 1.2 from return of age 1.1 (.008) and regression of 1.2 on 1.1 returns (74-89) R^2= .46; F1,14= 12.1 Y=181.8 (age 1.1) + 2.40

2) 94 forecast of age 1.3 from return of age 1.2 (2.01) and regression of 1.3 on 1.2 returns (81-88) R^2= .72; F1,7= 17.8 Y= .32(age 1.2)+ .74

Brood year	Escapement Number millions	Escapement Percent age .2	Age 2 smolt Number millions	Age 2 smolt Mean weight	Adult Return (millions) 2.1	2.2	2.3	Total	Smolt/ adult survival (%)	Mean length age 2.2
74	4.43	91	114	10.1	.301	16.38	.72	17.40	15.3	528
75	13.14	96	213	7.8	.298	28.18	.55	29.03	13.6	508
76	1.97	81	26	10.3	.043	3.85	.24	4.13	15.9	532
77	1.34	86	10	10.7	.002	.18	.09	.27	2.7	531
78	4.15	81	32	10.2	.016	1.24	.80	2.06	6.4	524
79	11.22	90	89	9.1	.073	17.01	3.28	20.36	22.9	504
80	17.50	96	76	8.5	.020	7.79	.38	8.19	10.8	523
81	1.75	82	38	10.0	.000	.91	.16	1.07	2.8	536
82	1.14	65	2	9.2	.001	.50	.14	.64	32.1	521
83	3.57	93	53	10.4	.003	1.13	.54	1.67	3.2	533
84	10.49	80	330	7.0	.043	16.35	2.39	18.78	5.7	513
85	7.21	68	87	8.3	.028	13.08	1.51	14.62	16.8	497
86	1.18	74	7	10.0	.000	1.34	1.23	2.57	36.7	506
87	6.07	96	41	10.5	.030	4.24	.68	4.95	12.1	514
88	4.06	56	34	9.9	.019	4.02	**.80**			538
89	8.32	90	61	9.1	.117	**12.77**				

1) 94 forecast of age 2.2 from return of 2.1 (.117) and mean weight of smolts (9.1) R^2= .90; F2,12= 53.9 Y= 43.2 + 55.7(age 2.1) - 4.06 (smolt wt)

2) 94 forecast of age 2.3 from return of age 2.2 (4.0) and regression of 2.3 on 2.2 returns (81-87) R^2= .80; F1,5= 19.6 Y= .111 (age 2.2) + .35

Table 12. Sockeye salmon escapements and returns to the Naknek and Branch rivers.

Naknek

Brood year	Escapement Number millions	Escapement Percent age .2	Adult return (millions) 1.1	1.2	1.3	2.1	2.2	2.3	Total	Mean length 1.2	Mean length 2.2
81	1.80	29	.004	.76	2.48	.008	.46	1.46	5.17	475	502
82	1.16	13	.003	.18	.75	.000	.21	.45	1.59	477	487
83	.89	65	.000	.14	.48	.007	.32	.45	1.40	475	506
84	1.24	65	.001	.46	.88	.022	1.17	1.76	4.29	480	491
85	1.85	58	.002	.64	3.41	.019	1.26	2.68	8.01	471	472
86	1.98	21	.003	1.90	6.95	.006	1.23	2.61	12.70	451	475
87	1.06	20	.000	.32	1.18	.004	.53	3.11	5.14	461	476
88	1.04	48	.000	.27	.76	.013	.47	**1.30**	2.81	448	493
89	1.16	68	.001	.21	**.72**	.005	**.51**			467	
90	2.09	56	.001	**1.36**							

1) 94 forecast of age 1.2 from escapement (2.09) and regression of 1.2 on escapement.
   R^2= .68 Y=1.114(escapement) - .97
2) 94 forecast of age 1.3 from return of 1.2 (.21) and regression of 1.3 on 1.2 returns.
   R^2= .94 Y= 3.72(1.2 return) - .06
3) 94 forecast of age 2.2 from return of 2.1 (.005) and regression of 2.2 on 2.1 returns.
   R^2= .45 Y= 38.65(2.1 return) + .32
4) 94 forecast of age 2.3 from return of 2.2 (.47) and regression of 2.3 on 2.2 returns.
   R^2= .21 Y= 1.00(2.2 return) + .87

Branch River

Brood year	Escapement Number millions	Escapement Percent age .2	Adult return (millions) 1.1	1.2	1.3	2.1	2.2	2.3	Total
81	.08	49	.000	.05	.17	.000	.05	.01	.28
82	.24	15	.000	.17	.13	.000	.00	.00	.30
83	.10	85	.000	.14	.13	.000	.03	.00	.30
84	.22	37	.001	.15	.14	.000	.04	.02	.35
85	.12	30	.003	.35	.11	.000	.09	.01	.56
86	.23	64	.001	.33	.26	.000	.19	.01	.79
87	.15	63	.000	.15	.16	.000	.16	.08	.55
88	.19	60	.001	.15	.14	.000	.26	**.02**	.57
89	.20	79	.005	.33	**.16**	.002	**.14**		
90	.17	85	.002	**.24**					

1) 94 forecast for age 1.2 from return of age 1.1 (.002) and regression of 1.2 on 1.1 returns
   R^2= .57; F= 9.3 Y= .145 + 46.934(age 1.1 return)
2) 94 forecasts of returns for ages 2.2, 1.3 and 2.3 from recent 5-year averages.

Table 13. Egegik sockeye salmon statistics to forecast runs by freshwater age (ordered by number of smolt).

Smolt Year	Escapement Number millions	Escapement Percent age .2	Age 1 smolt Number millions	Age 1 smolt Mean weight	Adult Return (millions) 1.1	1.2	1.3	Total	Smolt/ adult survival (%)	Mean length age 1.2
89	1.27	54	72	8.9	.000	.86	4.34	5.20	7.2	496
85	0.79	88	55	10.4	.002	1.72	2.69	4.41	8.0	509
88	1.15	74	36	10.2	.002	1.76	3.59	5.35	14.9	483
84	1.03	88	17	10.1	.002	1.01	1.79	2.80	16.5	510
86	1.17	69	14	9.0	.001	.58	.93	1.51	10.8	502
92	2.19	70	6	9.7	.000	**.44**				
91	1.61	58	5	10.3	.000	.59	**1.23**			522
90	1.61	57	4	9.6	.001	.40	1.43	1.83	45.7	472
87	1.10	67	4	11.6	.000	.54	1.33	1.87	46.8	511
83	0.69	71	2	9.5	.000	.52	.95	1.47	73.5	519

1) 94 forecast of age 1.2 from return of age1.1 (0) and number of age 1 smolt (6)
R^2= .79; F2,6= 11.0 Y= .39 + 303.3(age 1.1) + .0083(age 1 smolt)
2) 94 forecast of age 1.3 from number of age 1. smolt (5) and regression of age1.3 on age 1 smolt
R^2= .81 Y= 1.01 + .0438(age 1 smolt)

Smolt Year	Escapement Number millions	Escapement Percent age .2	Age 2 smolt Number millions	Age 2 smolt Mean weight	Adult Return (millions) 2.1	2.2	2.3	Total	Smolt/ adult survival (%)	Mean length age 2.2
91	1.61	58	89	15.6	.063	10.24	**11.65**			520
90	1.27	54	52	14.5	.064	8.41	10.73	19.20	36.9	492
87	1.17	69	46	14.1	.083	6.17	4.74	10.91	23.7	524
84	0.70	71	32	12.2	.060	3.30	1.39	4.69	14.7	528
86	0.79	88	30	15.7	.007	3.03	2.61	5.64	18.8	520
89	1.15	74	27	15.4	.010	3.79	4.21	8.00	29.6	502
92	1.61	54	17	13.3	.034	**2.92**				
88	1.10	67	13	14.3	.031	4.17	1.22	5.39	41.5	498
85	1.03	29	11	16.8	.012	1.74	1.59	3.33	30.3	529

1) 94 forecast of age 2.2 from number of smolt (17) and regression of smolt on return of 2.2
R^2= .84 Y= 1.11 + .1066(age 2 smolt)
2) 94 forecast of age 2.3 from return of age 2.2 (10.24) and regression of 2.3 on 2.2 returns
R^2= .80 Y= 1.341(Age 2.2) - 2.08

Table 14. Ugashik sockeye salmon statistics to forecast runs by freshwater age (ordered by number of jacks).

Brood year	Escapement Number millions	Escapement Percent age .2	Age 1 smolt Number millions	Age 1 smolt Mean weight	Adult return (millions) 1.1	1.2	1.3	Total	Smolt/ adult survival (%)	Mean length age 1.2
89	1.68	84	26	7.7	.007	.66	**.89**			517
81	1.33	42	31	7.6	.002	1.51	2.51	4.02	13.0	514
88	0.64	54	15	6.7	.002	.45	.67	1.12	7.5	498
86	1.00	41	183	5.7	.001	.48	2.38	2.86	1.6	488
87	0.67	56	89	6.5	.001	.81	1.55	2.36	2.7	502
82	1.16	20	75	6.8	.001	.41	.69	1.10	1.5	514
85	1.00	75	6	7.9	.001	.49	.69	1.18	19.7	507
90	0.73	60			.001	**.55**				
84	1.24	81	38	5.8	.000	.45	.55	1.00	2.6	512
83	1.00	90	13	8.3	.000	.60	.34	0.94	7.2	512

1) 94 forecast of age 1.2 from average return from 1,000 age 1.1 (.55)

2) 94 forecast of age 1.3 from return of age1. 2 (.66) and number of age 1 smolt (26)
R^2= .91; F2,5= 26.9 Y= 1.743(age 1.2) + .0102(age 1 smolt) - .53

Brood year	Escapement Number millions	Escapement Percent age.2	Age 2 smolt Number millions	Age 2 smolt Mean weight	Adult return (millions) 2.1	2.2	2.3	Total	Smolt/ adult survival (%)	Mean length age 2.2
84	1.24	81	21	11.1	.054	3.50	.69	4.19	20.0	523
88	0.64	54	48	11.6	.026	2.03	**.45**			527
89	1.68	84			.014	**1.72**				
87	0.67	56	39	11.8	.010	1.78	2.26	4.04	10.4	499
83	1.00	90	15	10.9	.006	.59	.30	.89	5.9	528
81	1.33	42	83	10.3	.004	2.20	.90	3.10	3.7	524
85	1.00	75	33	10.8	.002	.95	.46	1.41	4.3	504
89	1.00	84	35	10.7	.001	1.83	1.63	3.46	9.9	506
82	1.16	20	21	11.8	.001	.58	.72	1.30	6.2	517

1) 94 forecast of age 2.2 from return of age 2.1 (.014) and regression of 2.2 on 2.1 returns
R^2= .64; F1,6= 10.7 Y= 1.13 + 42.22(age 2.1)
2) 94 forecast of age 2.3 from mean length of age 2.2 (527) and regression of return on length
R^2= .48; F1,5=4.5 Y= 22.9 - .0426(mean length)

Table 15. Sockeye salmon escapements and returns to the Wood and Igushik rivers.

Wood River

Brood year	Escapement: Number millions	Escapement: Percent age .2	Fry on 9/1 (yr+1): Index catch	Fry on 9/1 (yr+1): Mean length	Adult return (millions): 1.1	1.2	2.2	1.3	2.3	Total	Mean length of 1.2
81	1.23	37	52	53	.000	.60	.08	1.14	.09	1.91	490
82	.98	34	10	61	.003	.50	.13	.90	.02	1.55	501
83	1.36	75	4	63	.001	1.91	.02	1.23	.07	3.23	495
84	1.00	22	38	55	.000	.52	.03	1.32	.02	1.89	502
85	.94	49	11	55	.003	1.11	.03	1.37	.01	2.52	501
86	.82	36	9	55	.002	1.16	.07	1.94	.06	3.23	480
87	1.34	82	4	57	.000	1.36	.09	.74	.09	2.28	486
88	.87	37	11	56	.001	1.59	.09	1.39	**.05**		482
89	1.19	49	9	58	.004	2.17	**.06**	**1.40**			496
90	1.07	50	23	57	.001	**1.50**					

1) 94 forecasts from recent 5-year averages (smolt estimates and spawner distribution not available)

Igushik

Brood Year	Escapement: Number millions	Escapement: Percent age .2	Mean air temp. for: Fry Apr-Oct	Mean air temp. for: Smolt Apr-May	Adult return (millions): 1.2	2.2	1.3	2.3	Total	Length of 1.2
81	.59	24	5.8	4.7	.15	.00	.83	.05	1.03	512
82	.42	5	7.6	1.9	.05	.01	.48	.01	.55	548
83	.18	73	6.8	-1.6	.15	.01	.33	.03	.52	508
84	.19	9	5.0	1.6	.03	.05	.63	.03	.74	525
85	.21	37	6.7	2.5	.51	.08	.90	.08	1.57	525
86	.31	7	7.5	2.4	.23	.03	2.20	.03	2.49	494
87	.17	40	6.9	3.7	.16	.01	.57	.03	.77	516
88	.17	12	8.3	5.0	.19	.04	1.02	**.04**		503
89	.46	49	7.8	4.1	.48	**.06**	**.36**			519
90	.37	25	8.0	2.7	**.31**					

1) 94 return of age 1.2 from recent 5-year average
2) 94 return of age 2.2 from return of 1.2 (.48) and regression of 2.2 on 1.2 return
   R^2=..42 Y= .007 + .1186 (1.2 Ret)
3) 94 return of age 1.3 from percent age 2 in escape. (49) and length of 1.2 (519)
   R^2= .71 Y= 14.30 - .0149(%.2 Esc) - .0253(Length 1.2)
4) 94 return of Aage 2.3 from recent 5-year average

Table 16. Sockeye salmon escapements and returns to the Nushagak and Togiak rivers.

Nushagak/Nuyakuk

Brood year	Escapement Number millions	Escapement Percent age .2	Adult return (millions) 0.2	0.3	0.4	1.2	1.3	1.4	Total	Mean length 1.2	Mean length 1.3
81	1.01	13	.01	.12	.01	.16	1.43	.06	1.79	487	554
82	.60	7	.04	.33	.05	.16	.85	.06	1.49	497	572
83	.40	35	.10	.57	.12	.11	.62	.02	1.54	502	570
84	.59	16	.01	.22	.03	.12	.55	.02	.95	493	568
85	.50	48	.06	.49	.06	.06	.59	.01	1.27	459	558
86	.99	6	.06	.83	.06	.11	.67	.21	1.94	471	554
87	.39	28	.14	.92	.25	.04	.52	.10	1.97	462	541
88	.48	16	.07	.52	.12	.21	1.39	**.07**	2.38	468	573
89	.50	14	.07	.47	**.08**	.12	**.82**			480	
90	.67	22	.05	**.43**		**.12**					
91	.50	5	**.07**								

1) 94 forecast for age 0.2 from escapement (.50) and regression of escape. on 0.2
   R^2=.38 Y = .127 - .1082(Escapement)
2) 94 forecast of age 0.3 from age 0.2 return (.07) and regression of 0.3 on 0.2 return
   R^2= .72 Y = 5.368(age 0.2 return) + .16
3) 94 forecast of age 0.4 from return of 0.3 (.47) and regression of 0.4 on 0.3 return
   R^2=.59 Y = .2107(age 0.3 return) - .018
4) 94 forecast of age 1.2 from percent age .2 in escapement (22) and regression of 1.2 on % .2
   R^2=.37 Y = .17 - .0022(Esc. % age .2)
5) 94 forecast of age 1.3 from return of age 1.2 (.47) and regression of 1.3 on 1.2 return
   R^2=.67 Y = 5.497(age 1.2 return) + .16
6) 94 forecast of age 1.4 from recent 5-year average

Togiak

Brood year	Escapement Number millions	Escapement Percent age .2	Adult return (millions) 0.2	0.3	1.2	1.3	2.2	2.3	Total	Mean length 1.2	Mean length 1.3
81	.31	30	.002	.01	.05	.24	.01	.02	.33	501	568
82	.29	28	.000	.02	.11	.24	.01	.02	.40	513	579
83	.21	41	.001	.00	.28	.91	.01	.02	1.22	516	586
84	.15	20	.000	.01	.02	.11	.00	.02	.16	520	583
85	.15	27	.000	.01	.03	.21	.04	.08	.37	513	579
86	.20	39	.000	.03	.08	.44	.08	.11	.74	504	572
87	.28	73	.000	.01	.19	.53	.03	.08	.84	514	567
88	.31	3	.001	.01	.11	.39	.03	**.06**	.60	515	592
89	.10	24	.000	.04	.12	**.41**	**.04**			522	
90	.19	48	.001		**.11**						

1) 94 forecasts of ages 1.2 and 2.2 from recent 5-year averages
2) 94 forecast of age 1.3 from return of 1.2 (.12) and regression of age 1.3 on 1.2 returns
   R^2= .88 Y = 2.701(age 1.2 return) + .09
3) 94 forecast of age 2.3 from return of 2.2 (.03) and regression of 2.3 on 2.2 returns
   R^2= .87 Y = 1.312(age 2.2 return) +.016