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FORECASTS OF THE 1997 SOCKEYE SALMON RUNS TO BRISTOL BAY

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A REPORT TO
BRISTOL BAY PROCESSORS

ACKNOWLEDGMENTS

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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 <1 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 regulating 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).

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 in 1985, salmon processors asked that FRI make forecasts from these same data to provide a second opinion. This report presents a review of the 1996 season and forecasts of the 1997 sockeye salmon runs to Bristol Bay, which are based mostly on preliminary statistics provided by ADF&G.

REVIEW OF THE 1996 RUN

FORECASTS AND ACTUAL RUNS

The FRI prediction of total run to Bristol Bay in 1996 was 45 million with a 33 million catch, and the ADF&G predictions were nearly the same at 43 and 35 million (Table 1). The ADF&G forecasts resulting from its statistical analyses were increased by ~33% to adjust for a recent tendency to underforecast the runs (Geiger and Simpson 1995). Therefore, ADF&G’s database for the 1996 forecast actually indicated a much lower run than forecast by FRI. The total 1996

run and catch (37 and 29.7 million) as well as most individual district runs were less than the pre-season forecasts from both agencies.

The catch of 29.7 million was 11% smaller than we predicted and the smallest for Bristol Bay since 1991. For the past 8 years, the catches have differed from our forecasts by an average of 24% (range: 3–74%) and from the ADF&G forecasts by an average of 39% (range: 10–125%). Therefore, both forecasts were relatively accurate in predicting the catch in 1996.

In addition to the preseason forecasts, we have made inseason forecasts each year since 1987 from a test-fishing program based out of Port Moller. This project, which was originally operated by ADF&G (1968–85), has provided more accurate predictions than preseason forecasts because we are estimating the relative abundance of the run just 6–8 days before it arrives in the fishing districts. Prior to the 1996 season, a Bristol Bay almanac was provided to processors so they could make daily forecasts of the final 1996 run beginning June 20. The forecast method was based on the past daily cumulative Port Moller indices and the past runs, and assumed average run timing. Very early in 1996 (around June 19), the test boat catches and ocean temperatures indicated that the run was going to be large, earlier than average, and contain a higher percentage of 3-ocean fish than expected (Table 2). However, the sockeye salmon at Port Moller were large (by age and sex) and distributed closer inshore than in past years, which suggested that the 1996 indices may be causing overestimation of abundance. The Port Moller samples did provide an accurate estimate of the age composition in the 1996 run, which was not so for preseason forecasts nor the False Pass fishery (Table 3).

THE FISHERIES

The Port Moller program indicated that the 1996 run was going to be large and ~2 days early in timing. The first major catch was made on June 24 in the Egegik fishery (Tables 4 and 5). Total daily catches exceeded 1 million from June 25 to July 9 with the largest single day catch on July 1 (2.5 million); the 50% point for the total catch was reached on July 3, ~3 days earlier than average. Management of the 1996 runs was generally very good with excess escapement occurring only in the Nushagak fishery, where the run was stronger than expected. An unexpected weak run to the Kvichak caused some disruption in the last half of the Naknek/Kvichak fishery when fishing was restricted to the Naknek River. The Kvichak escapement was still quite small (1.5 million) relative to the goal of 4 million. However this should have little impact on future Kvichak runs because the 1995 and 1996 smolt migrations and the 1994 and 1995 escapements were large.

FISH SIZE

The sockeye salmon caught in Bristol Bay in 1996 averaged 6.4 lb and were the largest since 1982 (Table 6). This was caused by a high percentage of 3-ocean fish (77%) but only average size by age and sex (Fig. 2). The body size of Bristol Bay sockeye salmon is inversely related to the number of fish in the run (large run, small fish) and 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), but the spring nearshore surface temperatures in the Gulf of Alaska in 1996 are not known. The sockeye salmon caught in the False Pass fishery were also large this year, and they were again very difficult to catch, just as in 1994–95. This indicates that some unusual ocean conditions have prevailed for the past 3 years.

FORECASTS FOR 1997

The statistics used to forecast the 1997 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 [1994] and Crawford and Cross [1994]); (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. [1996]); and (3) air temperatures for Bristol Bay were from monthly reports by the US Weather Bureau. The Bristol Bay run statistics used in forecasting do not include estimates of interceptions (i.e., fish caught on the high seas or at False Pass). We are forecasting the inshore run from inshore statistics. The climate for the 3 brood years (1991–93) that will contribute to the 1997 run was generally favorable (Fig. 3).

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 recent 5-year average of escapements. To predict the return of an age group in 1995, all relevant statistics from past brood years (since 1981) were assembled and submitted to a stepwise multiple regression procedure. When no measurement (variable) was significantly correlated with past variation in a run, then the average runs for the past 5 years were used to predict the 1997 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, and the production of sockeye salmon at Egegik has increased greatly since 1980. Egegik was a low producer relative to the size of the lake (second largest in Bristol Bay); now production is more in line with the other systems in Bristol Bay. In addition, the more recent years are likely to help better predict events in 1997 than earlier observations. An exception to this was in the forecast of age 1.2 returns to the Kvichak (which has mainly 2-ocean fish). Here I used statistics starting with the 1974 brood year (1978 run) because recent years did not provide a statistically significant forecast and a 5-year average was not appropriate.

The forecast of the total 1997 Bristol Bay sockeye salmon run is 35.1 million with a predicted catch of 25.4 million (Table 7). Over the past 5 years, there have been large runs of 3-ocean fish, especially relative to the returns of 2-ocean fish in the preceding years (Table 8). The 2-ocean fish were generally small for these years; however, this was not so in 1996, so we might expect a smaller return of 3-ocean fish in 1997 from the small return of 2-ocean fish in 1996.

The databases and forecast statistics are presented in Tables 9–14. Egegik (a large return of jacks) and Kvichak (a large smolt migration) are expected to have larger runs in 1997 than they had in 1996; however, the other rivers are expected to have smaller runs in 1997 mainly as a result of the low return of jacks and 2-ocean fish in 1996 (Fig. 4). Because past runs have sometimes differed considerably from the preseason forecasts, it will again be very important for the industry to have an accurate inseason forecast from the Port Moller test fishery.

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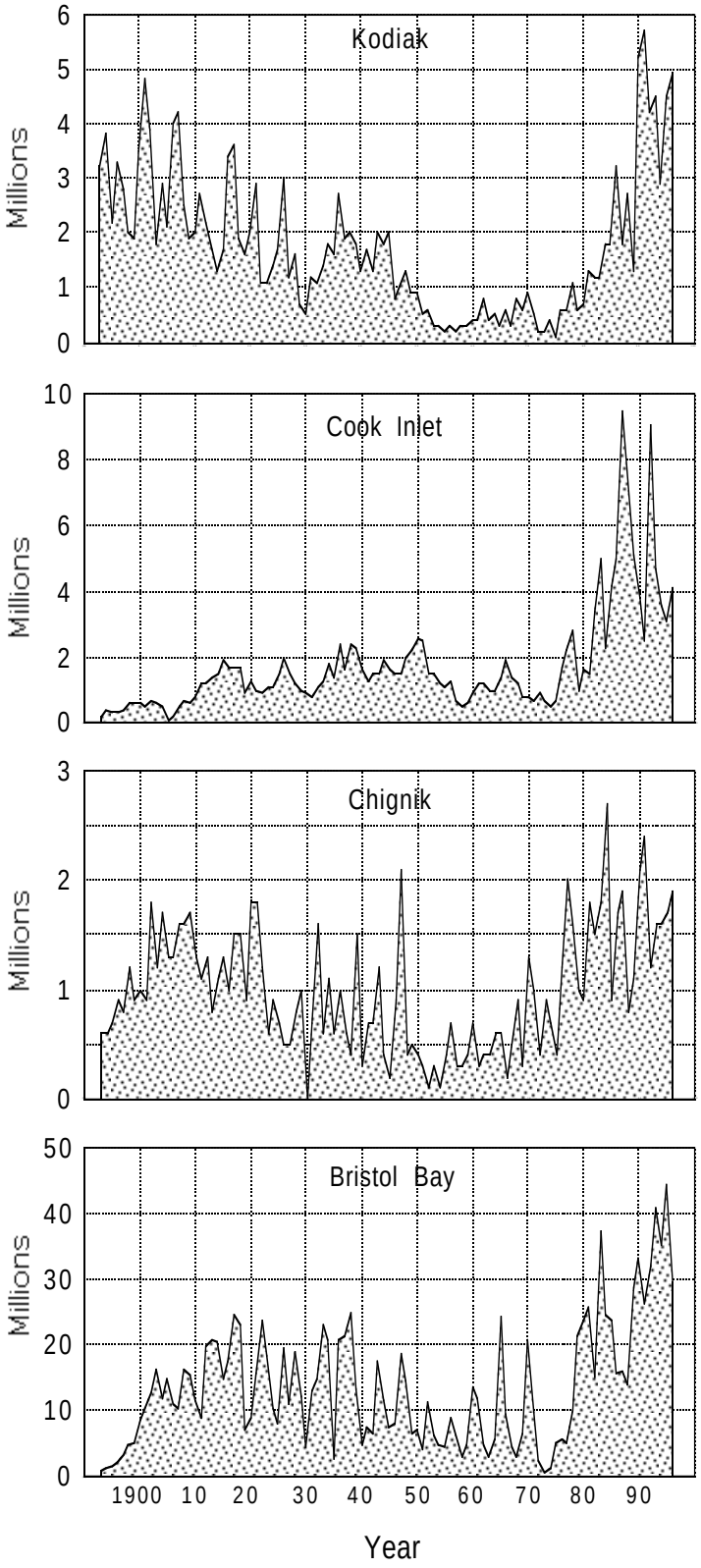

Figure 1. Annual commercial catches of sockeye salmon in the major Alaskan fisheries, 1893–1996.

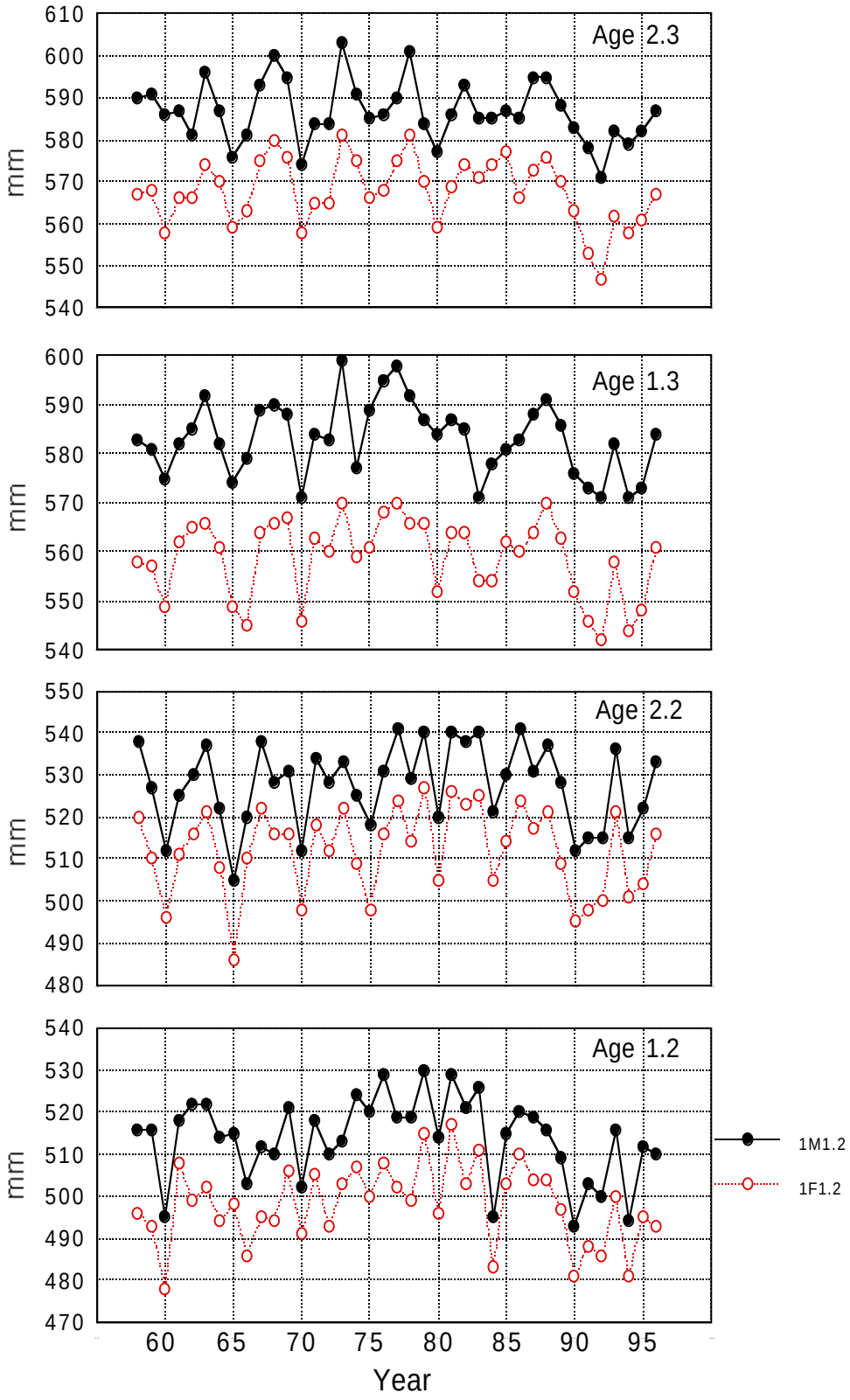

Figure 2. Annual mean lengths (mid-eye to tail fork) by age and sex for sockeye salmon in the Bristol Bay runs, 1958–96.

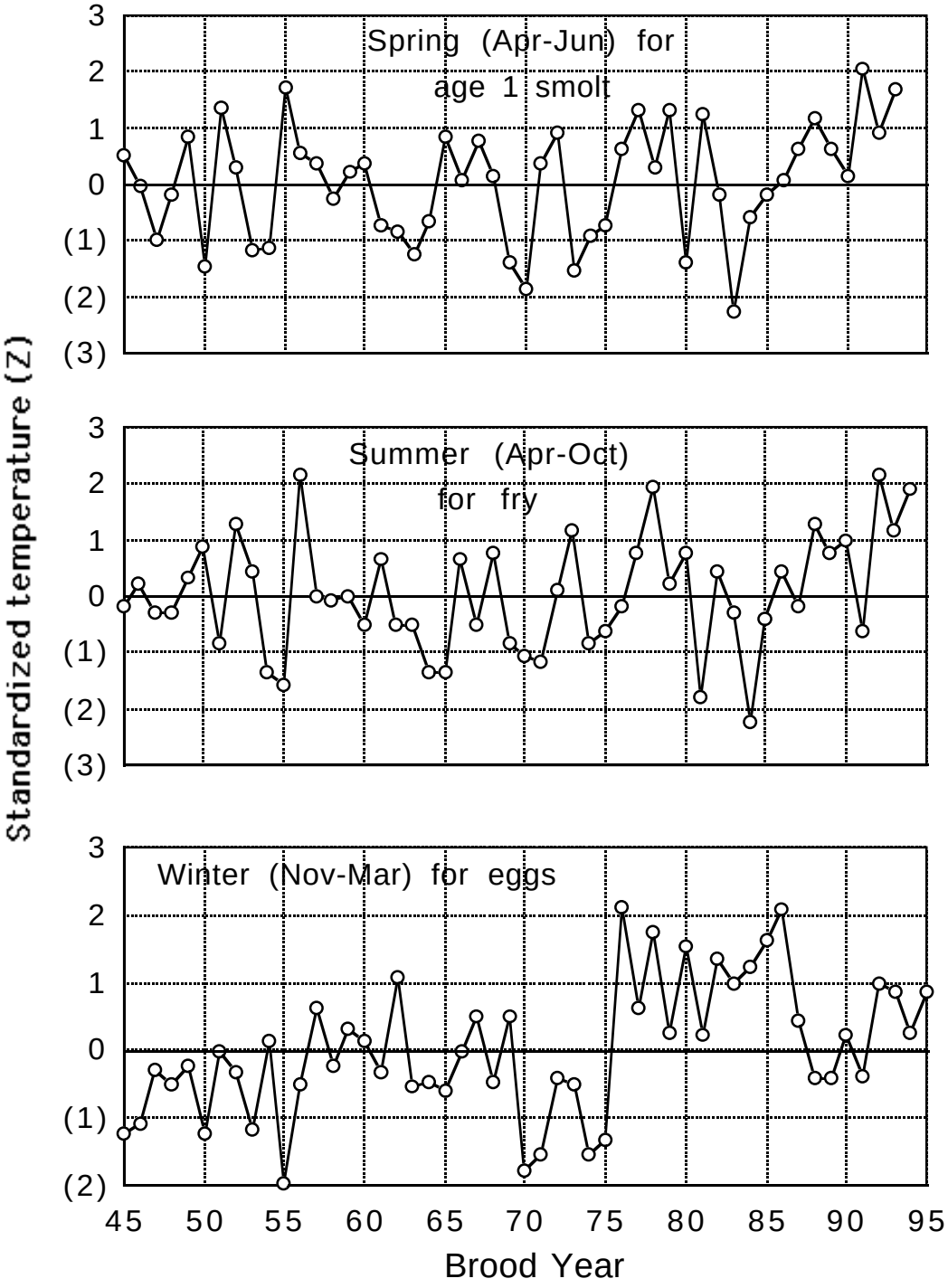

Figure 3. Relative air temperatures (number of standard deviations from the mean) in Bristol Bay (Dillingham and King salmon) for sockeye salmon brood years, 1945–93.

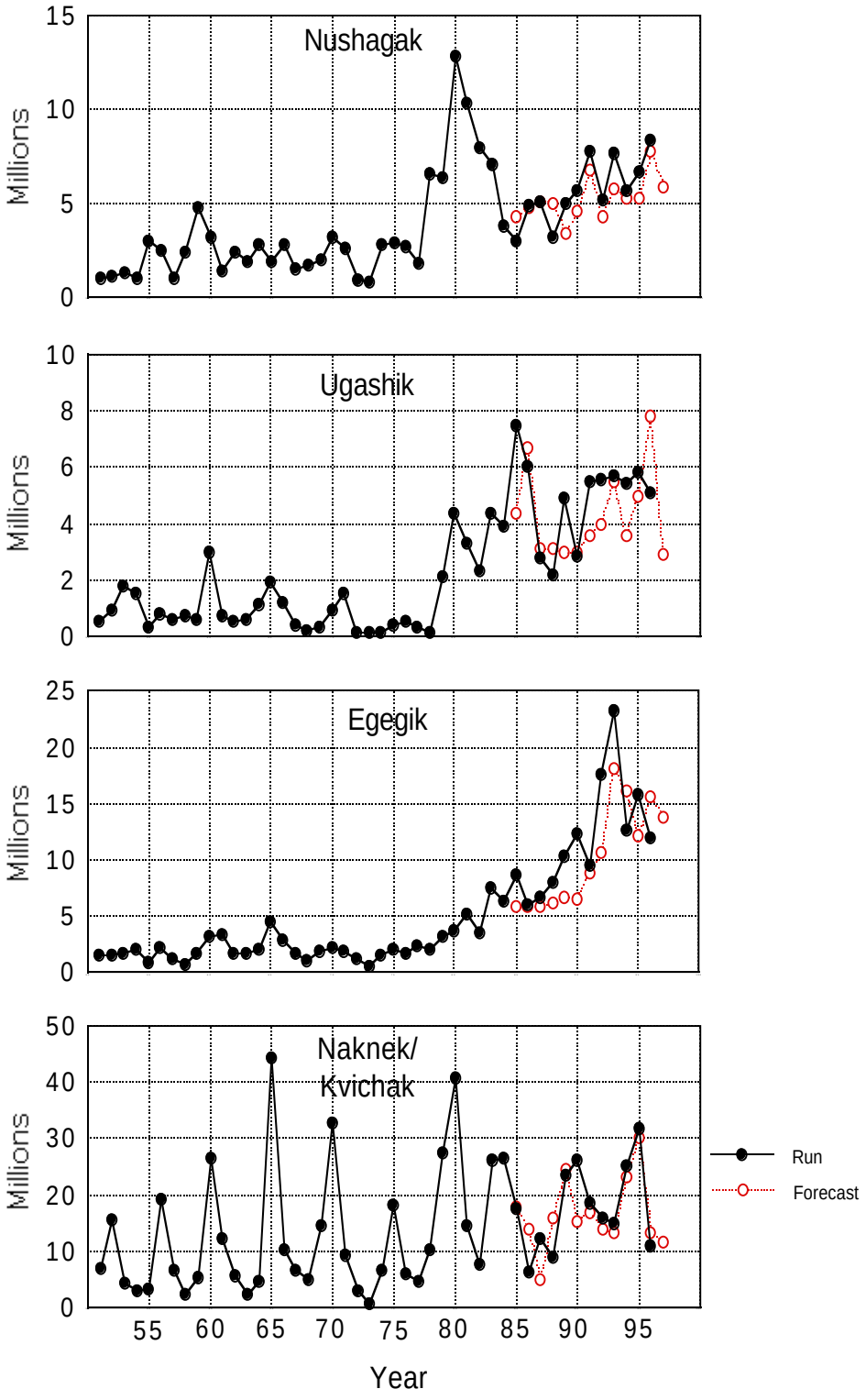

Figure 4. Sockeye salmon runs to the four major Bristol Bay fishing districts, 1951–96, and the FRI pre-season forecasts, 1985–97.

Table 1. Forecasts and actual runs to Bristol Bay, 1989–96 (in millions).

		Pre-season forecasts						Port Moller	
		ADF&G		FRI		Actual		forecast (7/2-6)	
Year	District	Run	Catch	Run	Catch	Run	Catch	Run	Catch
1989	Nak/Kvi	16.0	6.8	24.3	15.0	23.5	13.8	26.5	16.0
	Egegik	5.6	4.6	6.7	5.7	10.5	8.9	8.0	7.0
	Ugashik	3.6	2.9	3.0	2.2	4.9	3.1	2.5	1.5
	Nushagak	3.1	1.4	3.4	2.0	4.9	2.8	5.0	3.5
	Togiak	0.6	0.5	0.6	0.5	0.2	0.1	+	+
	TOTAL	28.9	16.2	38.0	25.4	44.0	28.7	42.0	28.0
1990	Nak/Nek	13.0	5.8	15.3	8.1	26.4	17.1	23.0	14.0
	Egegik	5.6	4.6	6.6	5.5	12.3	10.1	8.0	6.5
	Ugashik	3.1	2.4	3.0	2.3	2.9	2.1	3.0	2.0
	Nushagak	3.4	1.7	4.6	3.0	5.7	3.6	4.0	2.5
	Togiak	0.3	0.2	0.3	0.1	0.4	0.2	0.5	+
	TOTAL	25.4	14.7	29.8	19.0	47.6	33.1	38.5	25.0
1991	Nak/Nek	14.1	8.9	17.0	9.5	18.6	10.6	17.0	7.0
	Egegik	8.2	7.2	8.9	7.8	9.6	6.8	7.0	5.0
	Ugashik	3.5	2.8	3.6	2.7	5.5	3.0	5.0	4.0
	Nushagak	3.8	2.1	6.8	4.8	7.7	5.3	8.0	4.5
	Togiak	0.4	0.2	0.4	0.2	0.8	0.5	+	+
	TOTAL	30.0	21.2	36.7	25.0	42.2	26.2	37.0	20.5
1992	Nak/Kvi	16.9	9.7	13.8	7.2	15.9	9.4	14.0	8.0
	Egegik	10.7	9.7	10.4	9.0	17.5	15.7	16.0	14.0
	Ugashik	4.3	3.6	4.0	3.0	5.5	3.4	5.0	4.0
	Nushagak	4.6	2.9	4.3	2.5	5.2	2.9	5.0	3.0
	Togiak	0.6	0.4	0.5	0.3	1.0	0.7	0.5	+
	TOTAL	37.1	26.3	33.0	22.0	45.1	32.0	41.0	29.0
1993	Nak/Nek	15.5	9.3	13.1	6.9	14.6	8.9	12.0	7.0
	Egegik	15.8	14.8	18.2	16.2	23.3	21.8	18.5	17.0
	Ugashik	4.9	4.2	5.5	4.5	5.7	4.3	5.0	4.0
	Nushagak	5.1	3.3	6.0	4.0	7.6	5.3	6.0	4.0
	Togiak	0.5	0.4	0.5	0.3	0.7	0.5	0.5	0.3
	TOTAL	41.8	32.0	43.3	31.9	51.9	40.8	42.0	32.3
1994	Nak/Nek	22.5	13.3	23.1	13.1	25.6	16.3	25.2	14.0
	Egegik	18.5	17.5	16.2	14.2	12.7	10.8	11.3	10.0
	Ugashik	5.5	4.8	3.6	2.9	5.4	4.4	3.0	2.0
	Nushagak	5.5	3.8	5.3	3.5	5.9	3.4	5.0	3.0
	Togiak	0.5	0.4	0.6	0.4	0.5	0.3	0.5	0.3
	TOTAL	52.5	39.7	48.8	34.1	50.1	35.2	45.0	29.3
1995	Nak/Kvi	30.8	19.6	30.2	17.7	31.8	20.4	25.1	13.8
	Egegik	13.1	12.1	12.1	10.0	15.7	14.5	13.0	11.5
	Ugashik	5.4	4.7	5.0	3.4	5.8	4.5	5.0	4.0
	Nushagak	5.3	3.5	5.3	3.0	6.7	4.4	5.6	3.6
	Togiak	0.5	0.4	0.5	0.3	0.8	0.6	0.5	0.3
	TOTAL	55.1	40.3	53.1	34.4	60.8	44.4	49.2	33.2
1996	Nak/Kvi	13.9	8.7	13.2	7.5	11.0	8.2	11.5	8.0
	Egegik	16.9	15.9	15.7	13.8	11.9	10.8	15.0	14.0
	Ugashik	6.2	5.5	7.8	6.1	5.1	4.4	6.4	5.5
	Nushagak	5.8	4.1	7.7	5.4	8.3	5.8	7.7	5.7
	Togiak	0.6	0.4	0.8	0.6	0.7	0.5	0.6	0.4
	TOTAL	43.4	34.6	45.2	33.4	37.0	29.7	41.2	33.6

Table 2. Summary of 1996 Bristol Bay sockeye inseason forecasts (in millions) from the Port Moller test boat.

Date	Forecast from almanac	Date issued	Comment
June			
12			
15			
16			
17			
18		18	Average lengths of sockeye at PM indicate about 63% 3-ocean fish in the catches
19		19	Very early projection from PM is for a run in the upper 40s, mostly 3-ocean, and early
20	48		
21	48		
22	46	22	Nushagak catches and Wood River escapements through 6/21 are recent records; the Egegik
23	45		escapement and Naknek/Kvichak catch through 6/20 are the 2nd largest through that date
24	45		
25	45		
26	46		
27	46	27	Port Moller index is tracking along close to other years with runs of 40+ million (89, 91
28	47		and 92). Cumulative 96 BB catch + escapement through 6/26 is ahead of those same years
29	46		
30	44		
1	44	1	Average lengths of sockeye by age and sex at PM are above the recent year averages and
2	44		forecast a 1996 run of about 35 million; however confidence limits include a run of 45
3	46	3	River system forecasts totaling 41 million (33.6 catch) issued. Forecasts assummed runs
4	46		are 2 days early; PM index through 7/3 was used with the formula for 7/5 to forecast
5	45		total run then early catches, escapements and age compositions used to distribute the run.
6	47		Expect mid point of total Bay catch on July 4.
7	47		
Final run = 37			Run timing was early-- 50% of catch on July 3
catch = 30			Run contained 76% 3-ocean sockeye

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 preseason 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	45.1
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
1994	ADF&G	14	43	19	22	57	43	52.5
	FRI	17	37	15	29	55	45	48.8
	False Pass	8	34	33	22	42	57	
	Port Moller	7	42	20	28	50	50	41.0
	BB run	8	56	14	18	65	34	50.1
1995	ADF&G	16	53	17	13	69	31	55.1
	FRI	9	50	19	20	59	41	53.1
	False Pass	19	57	12	11	76	24	
	Port Moller	14	51	15	19	65	34	49.2
	BB Run	16	56	12	14	73	27	60.7
1996	ADF&G	18	36	26	19	54	48	43.4
	FRI	13	22	32	31	35	65	45.2
	False Pass	15	24	38	20	39	61	
	Port Moller	8	13	51	24	21	79	44.0
	BB Run	10	13	51	24	23	76	36.9

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.

Table 4. Timing of Nushagak and Naknek/Kvichak sockeye catches, 1958–96.

	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
94	3.4	2	2	26	68	16.3	+	+	15	58
95	4.5	1	26	56	73	20.4	1	19	40	71
96	5.8	5	32	49	90	8.2	6	27	63	86
Average (1981-96)	4.0	3	16	46	76	11.0	4	18	47	72

+ = <1%.

Table 5. Timing of Egegik and Ugashik sockeye catches, 1958–96.

	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
94	10.8	2	6	36	72	4.4	+	1	4	30
95	14.5	11	30	53	74	4.5	1	9	27	50
96	10.8	12	44	78	87	4.4	6	12	43	81
Average (1981-96)	9.0	8	27	54	80	3.3	2	6	20	52

Table 6. Average weights of sockeye (lb) in the Bristol Bay commercial catches, 1960–96.

	2-ocean			3-ocean			All	All	All	BB	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
94	4.9	4.4	4.6	7.0	5.7	6.3	5.7	4.9	5.3	35	39	54
95	5.1	4.4	4.8	6.9	6.1	6.1	5.6	4.9	5.3	44	29	45
96	5.3	4.5	4.9	7.5	6.2	6.4	7.0	5.8	6.4	30	77	50
Means												
85-96	5.2	4.6	4.9	7.3	6.2	6.7	6.2	5.4	5.8	28	51	51

Table 7. Forecasts of the 1997 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		5.6	1.0	6.6		0.4	0.4	0.8	7.4	
Naknek		0.3	0.5	0.8		1.3	1.6	2.9	3.7	
Branch		0.3	0.2	0.5		0.2	0.1	0.3	0.8	
	Naknek/Kvichak	6.2	1.7	7.9		1.9	2.1	4.0	11.9	6.3
	Egegik	1.3	6.7	8.0		3.6	2.3	5.9	13.9	12.9
	Ugashik	0.7	1.0	1.7		0.7	0.5	1.2	2.9	2.1
Wood		1.3	0.1	1.4		1.5	0.1	1.6	3.0	
Igushik		0.2	0.1	0.3		0.7	+	0.7	1.0	
Nush/Nuy		0.2	0.0	0.2	0.3	1.4	0.0	1.7	1.9	
	Nushagak	1.7	0.2	1.9	0.3	3.6	0.1	4.0	5.9	3.8
	Togiak	0.1	+	0.1		0.3	0.1	0.4	0.5	0.3
	Bristol Bay	10.0	9.6	19.6	0.3	10.1	5.1	15.5	35.1	25.4

+ = <100,000 predicted.

Table 8. Bristol Bay sockeye runs (millions) by age group, 1958–96 and forecasts for 1997.

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	12.1	10.0	22.7	1.1	45.1	32
93	0.2	6.7	17.2	24.0	9.6	17.1	27.3	0.6	52.1	41
94	0.2	4.3	28.3	32.8	7.2	8.9	17.0	0.3	50.3	35
95	+	9.8	34.2	44.3	7.2	8.8	16.3	0.2	60.8	44
96	0.1	3.9	4.7	8.7	18.7	8.7	28.1	0.1	37.0	30
97		**10.0**	**9.6**	**19.6**	**10.1**	**5.1**	**15.5**		**35.1**	**25**
Means 1987-96	0.1	6.9	16.4	23.4	10.8	7.8	19.2	0.3	43.0	30

Table 9. Kvichak sockeye salmon statistics for forecasting 1997 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	92	87	5.5	.002	2.01	1.56	3.57	4.1	511
90	7.00	91	18	5.6	.008	1.50	1.14	2.65	14.7	487
91	4.20	77	22	6.0	.001	2.59	1.23	3.82	17.4	506
92	4.73	77	54	5.7	.000	.41	**.39**			517
93	4.05	69	210	6.2	.001	**5.58**				

1) 97 forecast of age 1.2 from return of age 1.1 (.001) and number of smolt (210) for 1974-92. R^2=.57; F2,16=10.5 Y=.83+150(age 1.1)+.022(smolt)
2) 97 forecast of age 1.3 from return of age 1.2 (.41) and mean length of age 1.2 (517) for 1981-91. R^2=.79; F2,9=17.3 Y=10.6+.318(age 1.2)-.020 (1.2 length)

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	.53	4.57	13.4	538
89	8.32	92	61	9.3	.117	18.47	3.24	21.83	35.8	502
90	7.00	91	205	8.2	.082	20.55	1.22	21.85	10.7	510
91	4.20	77	30	9.5	.002	.67	**.43**			522
92	4.73	77	11	9.8	.002	**.98**				

1) 97 forecast of age 2.2 from return of 2.1 (.002) and number of age 2 smolt (11), 1981-91. R^2= .93; F2,8= 52.8 Y= .310 + 147(age 2.1) + .034 (age 2 smolt)
2) 97 forecast of age 2.3 from return of age 2.2 (.67) and regression for 1981-90. R^2=.63; F1,8=13.4 Y= .37 + .097 (age 2.2)

Table 10. Sockeye salmon escapements and returns to the Naknek and Branch rivers.

Naknek

Brood year	Escapement Number millions	Escapement % age .2	Smolt millions age 1	Smolt millions 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	37	49	.004	.76	2.48	.008	.46	1.46	5.17	475	502
82	1.16	13	32	13	.003	.18	.75	.000	.21	.45	1.59	477	487
83	.89	65	6	19	.000	.14	.48	.007	.32	.45	1.40	475	506
84	1.24	65	22		.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	.52	2.03	448	493
89	1.16	68			.001	.21	.87	.005	1.13	.55	2.77	467	470
90	2.09	56		29	.001	.39	1.18	.046	1.30	1.30	4.22	454	490
91	3.58	23	24	42	.013	.53	5.08	.001	.24	**1.62**		484	491
92	1.61	28	33		.000	.25	**1.33**	.001	**.52**			460	
93	1.54	21			.000	**.33**							

1) 97 forecast of age 1.2 from recent 5-year average (.33).
2) 97 forecast of age 1.3 from return of 1.2 (.25) and escapement (1.61).
   R^2= .93; F2,8= 54.4 Y= 3.02(1.2 return)+1.24(escape.) -1.42
3) 97 forecast of age 2.2 from return of age 2.1 (.001).
   R^2= .63; F1,9= 5.9 Y= ..50 + 21.5(age 2.1)
4) 97 forecast of age 2.3 from 5-year mean (1.63)

Branch River

Brood year	Escapement Number millions	Escapement % 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	.04	.59
89	.20	79	.005	.33	.16	.002	.17	.16	.83
90	.17	85	.002	.26	.12	.000	.32	.00	.70
91	.28	69	.000	.19	.22	.004	.16	**.06**	
92	.22	75	.002	.09	**.16**	.000	**.21**		
93	.35	76	.004	**.31**					

1) 97 forecast for age 1.2 from return of age 1.1 (.004) and regression of 1.2 on 1.1 returns
   R^2= .65; F1,10= 7.3 Y= .15 + 41.2(age 1.1 return)
2) 97 forecasts of returns for ages 2.2, 1.3 and 2.3 from recent 5-year averages.

Table 11. Egegik sockeye salmon statistics for forecasting 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
94	1.94	63	55	9.7	.000	.32	**3.59**			508
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
93	2.79	56	20	9.3	.001	1.33	3.87	5.20		502
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
95	1.52	44	7	9.3	.002	**1.30**				
92	2.19	70	6	9.7	.000	.40	.84	1.24	20.7	480
91	1.61	58	5	10.3	.000	.59	.43	1.02	20.4	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) 97 forecast of age 1.2 from return of age1.1 (.002) and regression of age 1.2 on age1.1
   R^2= .65; F1,10= 18.3 Y= .50 + 339(age 1.1)
2) 97 forecast of age 1.3 from number of age 1. smolt (55) and regression of age1.3 on age 1 smolt
   R^2= .64; F1,9=15.9 Y= 1.01+ .047(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	5.48	15.78	17.7	520
90	1.27	54	52	14.5	.064	8.41	10.73	19.20	36.9	492
95	1.95	65	50	11.6	.053	**6.74**				
87	1.17	69	46	14.1	.083	6.17	4.74	10.91	23.7	524
94	2.77	56	39	13.7	.020	2.98	**2.28**			520
93	2.19	70	38	12.2	.065	9.28	4.61	13.89	36.6	512
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	5.98	3.92	9.90	58.2	488
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) 97 forecast of age 2.2 from number of smolt (50) and regression of smolt on return of 2.2
   R^2= .53; F1,9= 10.3 Y= 1.97 + .095(age 2 smolt)
2) 97 forecast of age 2.3 from return of age 2.2 (2.98) and regression of 2.3 on 2.2 returns
   R^2= .49: F1,8= 7.5 Y= .674 (Age 2.2) - .27

Table 12. Ugashik sockeye salmon statistics for forecasting 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
81	1.33	42	31	7.6	.002	1.51	2.51	4.02	13.0	514
82	1.16	20	75	6.8	.001	.41	.69	1.10	1.5	514
83	1.00	90	13	8.3	.000	.60	.34	0.94	7.2	512
84	1.24	81	38	5.8	.000	.45	.55	1.00	2.6	512
85	1.00	75	6	7.9	.001	.49	.69	1.18	19.7	507
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
88	0.64	54	15	6.7	.002	.45	.67	1.12	7.5	498
89	1.68	84	26	7.7	.007	.66	.37	1.04	4.0	517
90	0.73	60			.001	.34	.67	1.01		488
91	2.48	57	58	8.0	.006	1.93	3.08	5.02	8.7	504
92	2.17	49	24	6.7	.003	.18	**.69**			498
93	1.41	48	7	7.8	.002	**.68**				

1) 97 forecast of age 1.2 from return age 1.1
R^2=.22; F1,10=2.8 Y=.47+107(age 1.1)

2) 97 forecast of age 1.3 from return of age1. 2 (.18) and mean length of age 1.2 (498).
R^2= .82; F2,8= 15.6 Y= 21.3 + 1.72 (age 1.2) - .042(ML age 1.2)

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
81	1.33	42	83	10.3	.004	2.20	.90	3.10	3.7	524
82	1.16	22	21	11.8	.001	.58	.72	1.30	6.2	517
83	1.00	90	15	10.9	.006	.59	.30	.89	5.9	528
84	1.24	80	21	11.1	.054	3.50	.69	4.24	20.2	523
85	1.00	75	33	10.8	.002	.95	.46	1.41	4.3	504
86	1.00	41	32	10.7	.001	1.83	1.63	3.46	10.8	506
87	0.67	56	39	11.8	.010	1.78	2.26	4.04	10.4	499
88	0.64	58	48	11.6	.026	2.03	2.18	4.24	8.8	527
89	1.68	84			.014	2.43	.93	3.37		490
90	0.73	61	12	12.5	.015	2.23	1.18	3.43	28.5	517
91	2.48	57	6	11.2	.001	.57	**.49**			512
92	2.17	49	15	11.1	.004	**.99**				

1) 97 forecast of age 2.2 from return of age 2.1 (.001) and age 2 smolt (15).
R^2= .78; F2,7= 12.5 Y=.56 + 47(age 2.1) + .016(age 2 smolt)

2) 97 forecast of age 2.3 from average of other years when there was less than 1.0 million age 2.2 (1982, 83, and 85)

Table 13. Sockeye salmon escapements and returns to the Wood and Igushik rivers.

Wood River

Brood year	Escapement Number millions	Escapement Percent age .2	Temperatures for Fry Apr-Oct	Temperatures for Smolt Apr-June	Adult return (millions) 1.1	1.2	2.2	1.3	2.3	Total	Mean length of 1.2
81	1.23	37	5.4	7.0	.000	.60	.08	1.14	.09	1.91	490
82	.98	34	7.5	4.9	.003	.50	.13	.90	.02	1.55	501
83	1.36	75	6.8	1.8	.001	1.91	.02	1.23	.07	3.23	495
84	1.00	22	5.0	4.3	.000	.52	.03	1.32	.02	1.89	502
85	.94	49	6.7	4.9	.003	1.11	.03	1.37	.01	2.52	501
86	.82	36	7.5	5.3	.002	1.16	.07	1.94	.06	3.23	480
87	1.34	82	6.9	6.1	.000	1.36	.09	.74	.09	2.28	486
88	.87	37	8.3	6.9	.001	1.59	.09	1.39	.03	3.10	482
89	1.19	49	7.8	6.1	.004	2.17	.01	1.82	.04	4.04	496
90	1.07	50	8.0	5.4	.001	1.08	.28	1.15	.16	2.67	477
91	1.16	36	6.5	8.2	.012	2.53	.05	2.43	**.06**		496
92	1.29	73	9.1	6.5	.001	2.32	**.10**	**1.51**			495
93	1.18	59	7.5	7.6	.000	**1.29**					

1) 97 return of age 1.2 from return age 1.1 (.000) and percent age .2 in escapement (59)
   R^2=.65; F2,9= 8.5 Y= 147 (age 1.1)+ .023 (% age .2) - .07
2) 97 forecast of age 1.3 was from return of age 1.2 (2.32) and percent age .2 in escapement (73)
   R^2=.83; F2,8=19.4 Y= 1.42 + .635(age 1.2) - .019(% age .2)
3) 97 return of age 2.2 from recent 5-year average (.10).
4) 97 return of age 2.3 from escapement (1.16) and return of age 2.2 (.05)
   R^2= .77; F2,7= 11.7 Y= .123 (escapement) + .453 (age 2.2) - .11

Igushik

Brood Year	Escapement Number millions	Escapement Percent age.2	Mean air temp. for: Fry Apr-Oct	Mean air temp. for: Smolt Apr-June	Adult returns (millions) 1.2	2.2	1.3	2.3	Total	Mean length of 1.2
81	.59	24	5.4	7.0	.15	.00	.83	.05	1.03	512
82	.42	5	7.5	4.9	.05	.01	.48	.01	.55	548
83	.18	73	6.8	1.8	.15	.01	.33	.03	.52	508
84	.19	9	5.0	4.3	.03	.05	.63	.03	.74	525
85	.21	37	6.7	4.9	.51	.08	.90	.08	1.57	525
86	.31	7	7.5	5.3	.23	.03	2.20	.03	2.49	494
87	.17	40	6.9	6.1	.16	.01	.57	.03	.77	516
88	.17	12	8.3	6.9	.19	.04	1.02	.04	1.29	503
89	.46	49	7.8	6.1	.48	.06	1.05	.05	1.64	519
90	.37	25	8.0	5.4	.16	.18	1.36	.15	1.85	494
91	.76	6	6.5	8.2	.31	.00	1.31	**.02**		507
92	.31	26	9.1	6.5	.04	**.06**	**.66**			517
93	.41	31	7.5	7.6	**.24**					

1) 97 returns of age 1.2 and 2.2 from recent 5-year averages.
3) 97 return of age 1.3 from return of age 1.2 (.04), percent age .2 in escapement (26), and the mean length of age 1.2 (517).
   R^2= .83: F3,6= 9.7 Y= 12.65 + 1.63 (age 1.2) - .016(%.2 Esc) - .0225(Length 1.2)
4) 97 returns of age 2.3 from return of age 2.2 (.003) and regression of age 2.3 on age 2.2
   R^2=.43; F1,7= 5.3 Y= .024 + .474 (age 2.2)

Table 14. 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	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	.06	2.37	468	573
89	.50	14	.07	.47	.03	.12	.66	.02	1.37	480	555
90	.67	22	.05	.75	.10	.04	.24	.01	1.19	454	556
91	.50	5	.01	.13	.01	.17	.99		1.31	461	569
92	.70	31	.08	.49		.22	**1.35**			486	
93	.72	11	.04	**.32**		**.15**					
94	.51	6									

1) 97 returns of age 1.2 from recent 5-year average.
2) 97 forecast of age 0.3 from age 0.2 return (.04) and mean length of age 1.2 (486).
   R^2= .84; F2,9=24.5 Y = 4.49 + 4.94(0.2 return) - .009(ML age 1.2)
3) 97 forecast of age 1.3 from return of age 1.2 (.22) and regression of 1.3 on 1.2 return
   R^2=.73; F1,9= 23.9 Y = .10 + 5.67(age1.2 return)

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	1.3
81	.31	19	.002	.01	.05	.24	.01	.02	.33	501	568
82	.29	30	.000	.02	.11	.24	.01	.02	.40	513	579
83	.21	28	.001	.00	.28	.91	.01	.02	1.22	516	586
84	.15	41	.000	.01	.02	.11	.00	.02	.16	520	583
85	.15	20	.000	.01	.03	.21	.04	.08	.37	513	579
86	.20	27	.000	.03	.08	.44	.08	.13	.76	504	572
87	.28	39	.000	.01	.19	.65	.03	.08	.96	514	567
88	.31	73	.001	.01	.13	.39	.03	.05	.61	515	592
89	.10	3	.000	.04	.12	.31	.01	.05	.53	522	561
90	.19	24	.001	.02	.10	.50	.08	.04	.74	495	570
91	.28	41	.001	.00	.20	.50	.03	**.06**	.79	516	589
92	.20	23	.001	.04	.06	**.26**	**.04**			525	
93	.19	24	.000		**.12**						

1) 97 forecasts of ages 1.2 and 2.2 from recent 5-year averages
2) 97 forecast of age 1.3 from return of 1.2 (.05) and regression of age 1.3 on 1.2 returns
   R^2= .81; F1,9= 38.9 Y = .10 + 2.61(age 1.2 return)
4) 97 forecast of age 2.3 from return of 2.2 (.03) and regression of 2.3 on 2.2 returns
   R^2= .55; F1,8=9.7 Y= .022 + .988 (age 2.2 return)