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FORECASTS OF THE 1999 SOCKEYE SALMON RUNS TO BRISTOL BAY USING TRADITIONAL FRI METHODOLOGY

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ANNUAL REPORT TO

BRISTOL BAY PROCESSORS

ACKNOWLEDGMENTS

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KEY WORDS

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

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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 30 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 1998 season and forecasts of the 1999 sockeye salmon runs to Bristol Bay, which are based mostly on preliminary statistics provided by ADF&G.

REVIEW OF THE 1998 RUN

Forecasts and Actual Runs

The FRI prediction of total run to Bristol Bay in 1998 was 34 million with a 23 million catch, and the ADF&G predictions were nearly the same at 30 and 21 million (Table 1). The total 1998 run and catch (18 and 10 million) as well as most individual district runs were much less than the preseason forecasts from both agencies.

The catch of 10.0 million was less than half of the predicted catch (as in 1997) and the smallest for Bristol Bay since 1978. From 1987–96, our forecasts differed from the actual catches by an average of 22% (range: 5–43%) and ADF&G forecasts differed by an average of 27% (range: 9–56%). In both 1997 and 1998, the forecasts differed from the actual catch by over 100% and thus were the most inaccurate forecasts made since 1990, when forecasts were only about one half of the actual catch.

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 has provided more accurate predictions (average error of 15%) 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 1998 season, a Bristol Bay almanac was provided to processors so they could make daily forecasts of the final 1998 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 1998 (June 20), the test boat catches and ocean temperatures indicated that the run was going to be close to preseason forecasts and a little earlier than average (Table 2). By June 24, the age compositions at Port Moller and in the False Pass fisheries showed a lack of age 2.2 sockeye, which were expected to provide about 30% of the run. There was also a low sockeye-to-chum ratio in the Port Moller catches that, combined with the age data, indicated the run was likely to be smaller than that forecast from the Port Moller sockeye index catches and the relatively large catches in the False Pass fisheries. Lack of fishing in the Naknek/Kvichak and Nushagak Districts through July 4 made it impossible to forecast the district runs and catches until July 7. A run of 20 million with a 10.7 million catch was forecast and run timing appeared to be later rather than earlier than average. The final run was 18 million with a 10 million catch. The age composition in the run was similar to the age composition predicted from the Port Moller samples (Table 3).

The Fisheries

The Port Moller program indicated that the 1998 run was going to be close to or below the preseason forecast of about 30 million and the catches in the False Pass June fisheries were also consistent with a 30 million run. The sockeye were late in arriving in the Naknek/Kvichak District and fishing did not begin until July 7. The first major catch in Bristol Bay was made on June 23 in the Egegik fishery, and the Egegik run appeared to be about average in timing; however, the mid-point of the run was 1 day later than average. Fishing in the Nushagak District did not begin until July 5 when over 50% of the Wood River escapement goal had passed the counting towers. Total daily catches only reached 1 million on July 7, and the 50% point for the total catch was not reached until July 9, about 4 days later than average. The timing of the Naknek/Kvichak and Nushagak runs was 2–3 days later than average. Management of the 1998 runs was generally good with excess escapement occurring only in the Nushagak fishery (Wood River). The Kvichak escapement was again quite small (2.3 million) relative to the goal of 4 million; however, escapements in the other major rivers exceeded management goals.

Physical conditions in Bristol Bay during the 1998 run were the opposite of conditions in 1997. Water flows were very high, skies were mostly cloudy, and water temperatures were cool during the 1998 run in contrast to the low water, clear skies, and warm temperatures during the 1997 run.

Fish Size

The sockeye salmon caught in Bristol Bay in 1998 averaged 2.5 kg (5.6 lb) and were close to the recent year average (Table 4). This was caused by an above-average percentage of 3-ocean fish (60%) and below-average sizes of all age groups (Fig. 2). The body size of Bristol Bay sockeye salmon has been 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). The spring nearshore surface temperatures in the Gulf of Alaska and in Bristol Bay were exceptionally warm in 1997 and above average in 1998. Combined with runs of only 19 and 18 million, this should have resulted in much larger sockeye salmon than observed. The age 1.2 and 1.3 sockeye were especially small in 1998 given the relatively small numbers in the run.

FORECASTS FOR 1999

The statistics used to forecast the 1999 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., Crawford and Cross 1994 and Stratton and Crawford 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. 1998); 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 (1993–95) that will contribute to the 1999 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 1999, 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 1999 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 1999 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, statistics were used 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 1999 Bristol Bay sockeye salmon run is 35.1 million with a predicted catch of 21.2 million (Table 5). Over the past 10 years, there have been larger runs of 3-ocean fish relative to the returns of 2-ocean fish in the preceding years (Table 6). The 2-ocean fish were generally small for these years and this was also the case in 1998, so we might expect larger returns of 3-ocean fish in 1999 than the small returns of 2-ocean fish in 1998. The databases and forecast statistics are presented in Tables 7–12. The runs to all districts are expected to be larger than the runs in 1997 and 1998 although still below the average runs over the past decade (Fig. 4). There were above average returns of jacks to Naknek, Egegik, Ugashik, and Wood River; however, the Kvichak, which might be expected to have the largest run of 2-ocean sockeye from the large smolt migration in 1997, had relatively few jacks in 1998.

The Kvichak run in 1999 will be coming from the pre-peak and peak cycle brood years of 1994 and 1995. The forecast of 7 million age 2.2 sockeye to the Kvichak, which was greatly influenced by the low return of age 2.1 jacks, is much smaller than the returns from the past pre-peak cycle years since 1974, all of which have been greater than 15 million (Fig. 5). The age 2.2 return might be much larger given the size of the parent escapement (8 million) and the relatively small return of age 1.2 sockeye in 1998. The age 1.2 return in 1999 might also be larger than the forecast of 5 million as there was a large age 1 smolt migration in 1997 and a comparatively large return of age 1.1 jacks in 1998 (Fig. 6). Most of the production from the 1995 escapement of 10 million will likely come as age 2.2 sockeye in 2000; however, given the above average growth of fry in 1996 and the warm spring in 1997, one might expect a greater return of age 1.2 sockeye than usual from a peak cycle year in the Kvichak.

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. The age composition in the 1999 Port Moller catches may be as informative as the catches themselves, as we should expect a high percentage of 2-ocean sockeye if the run is to be as large or larger than the preseason forecast.

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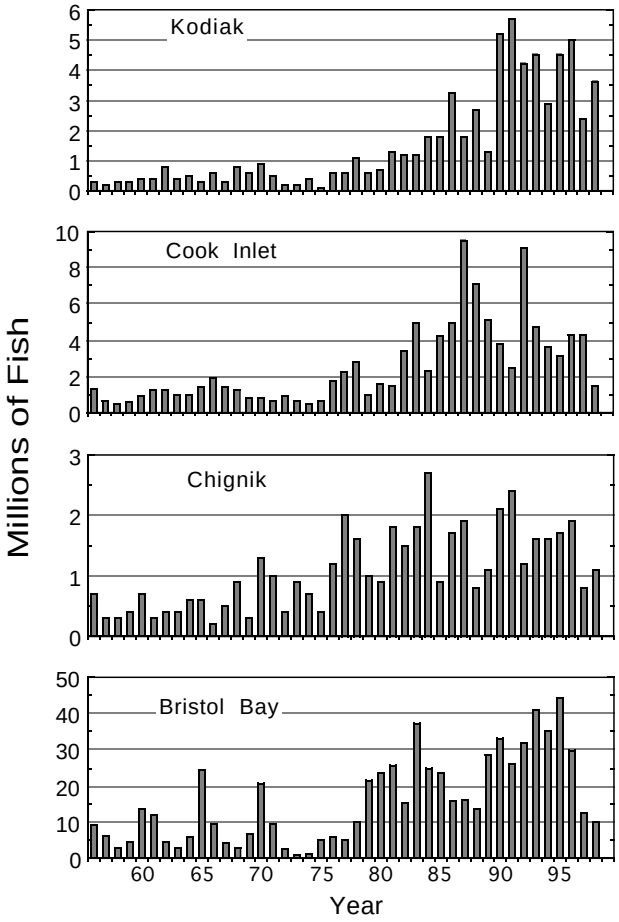

Figure 1. Annual commercial catches of sockeye salmon (*Oncorhynchus nerka*) in the major Alaskan fisheries, 1956–1998.

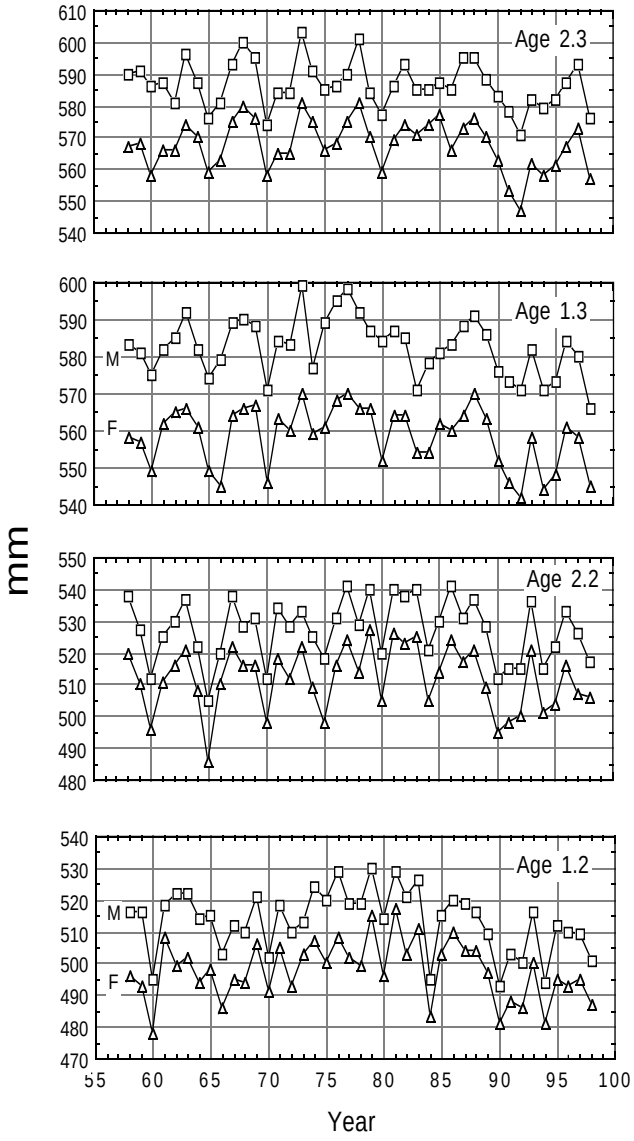

Figure 2. Annual mean lengths by age and sex for sockeye salmon in the Bristol Bay runs, 1958–98.

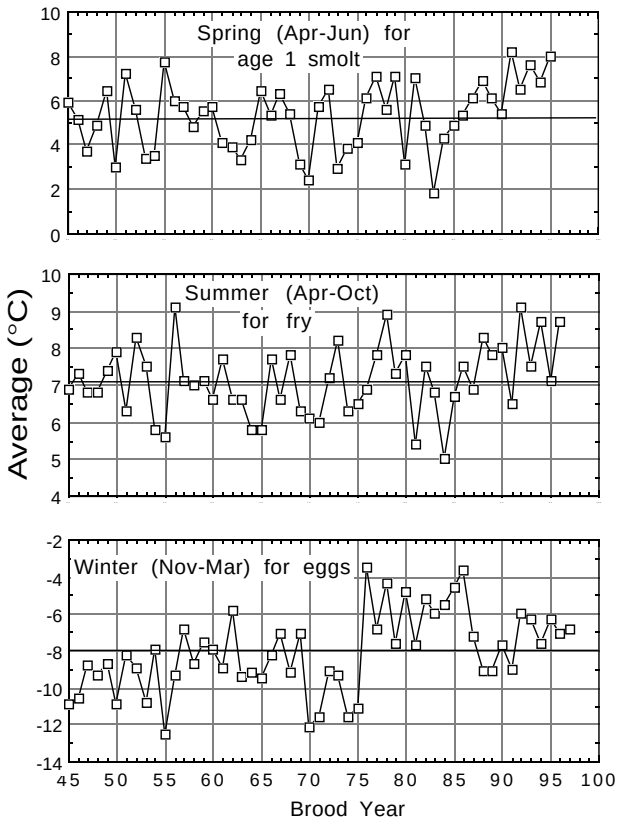

Figure 3. Air temperatures in Bristol Bay for sockeye salmon brood years, 1945–97.

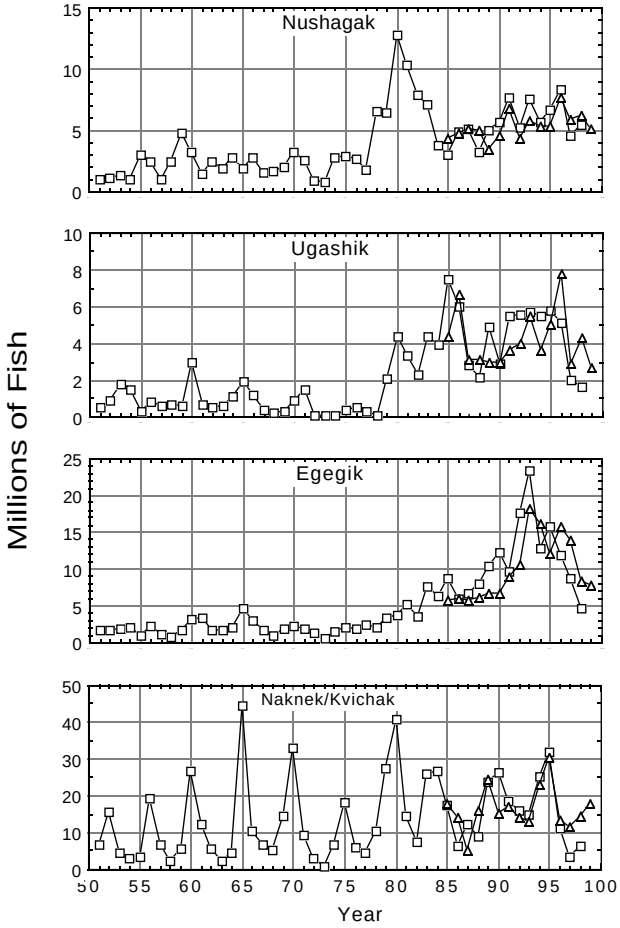

Figure 4. Sockeye salmon runs, 1951–98, and the FRI pre-season forecasts, 1985–99. Symbols: □ = run; ◇ = forecast.

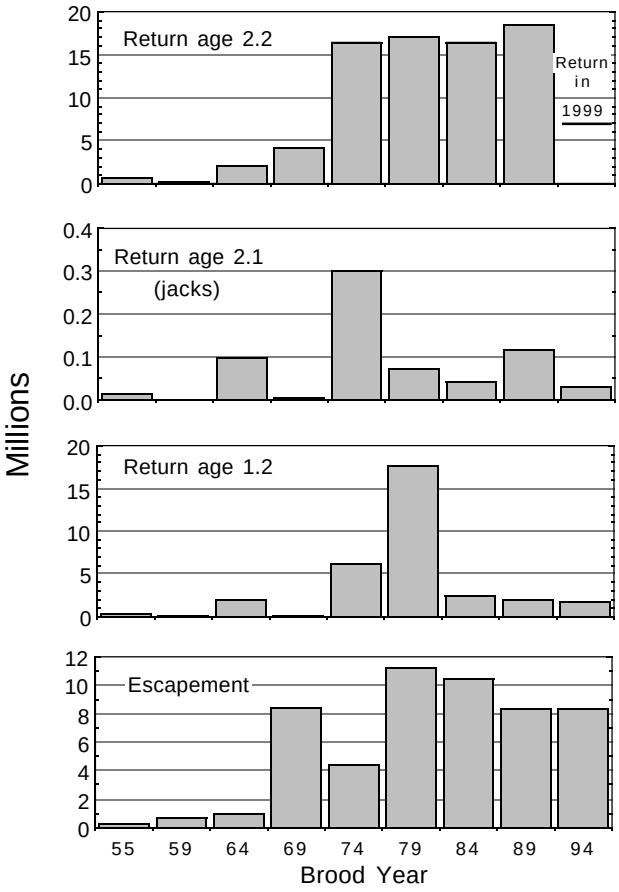

Figure 5. Kvichak sockeye salmon returns from pre-peak cycle years.

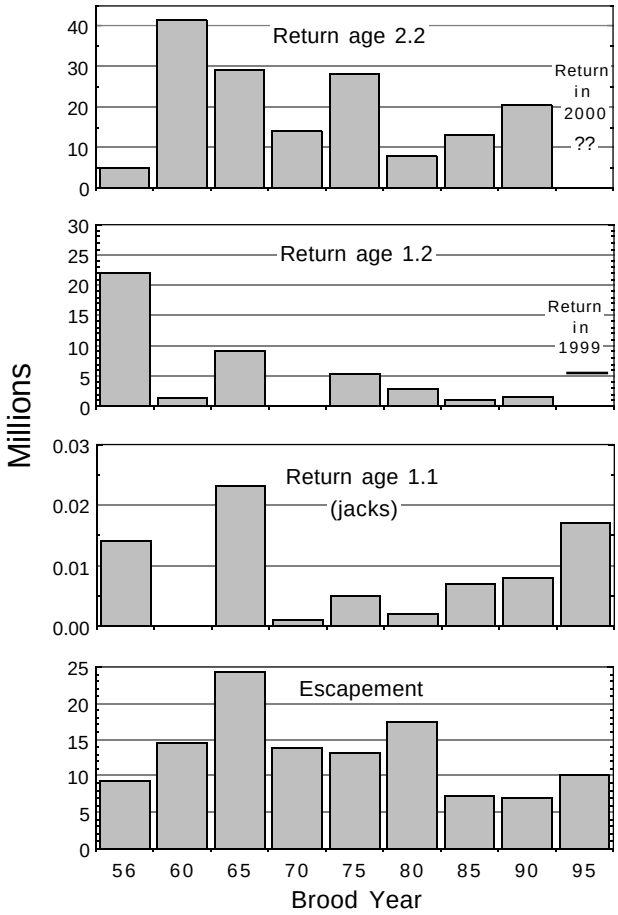

Figure 6. Kivchak sockeye salmon returns from peak cycle years.

Table 1. Forecasts and actual runs of sockeye salmon (*Oncorhynchus nerka*) to Bristol Bay, 1990–98.

		Pre-season forecasts						Port Moller	
		ADF&G		FRI		Actual		forecast (7/2-6)	
Year	District	Run	Catch	Run	Catch	Run	Catch	Run	Catch
1990	Nak/Kvi	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/Kvi	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/Kvi	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/Kvi	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
1997	Nak/Kvi	10.8	5.6	11.9	6.3	3.4	0.6	4.6	0.8
	Egegik	12.8	11.8	13.9	12.9	8.7	7.6	10.5	9.5
	Ugashik	3.8	3.1	2.9	2.1	2.0	1.4	5.2	3.0
	Nushagak	5.7	3.9	5.9	3.8	4.6	2.6	5	4
	Togiak	0.5	0.4	0.5	0.3	0.2	0.1	0.4	0.2
	TOTAL	33.6	24.8	35.1	25.4	18.9	12.3	25.7	17.5
1998	Nak/Kvi	12.6	6.9	14.5	8.2	6.3	2.6	5.5	1.1
	Egegik	8.6	7.5	8.4	7.4	4.7	3.6	5.3	4.3
	Ugashik	3.2	2.4	4.3	3.3	1.6	0.7	3.0	2.2
	Nushagak	5.3	3.5	6.2	4.4	5.4	3.0	5.7	2.8
	Togiak	0.5	0.3	0.4	0.2	0.3	0.1	0.5	0.3
	TOTAL	30.2	20.6	33.8	23.5	18.3	10.0	20.0	10.7

Table 2. Summary of 1998 Bristol Bay sockeye inseason forecasts from the Port Moller test boat.

Date	Forecast from almanac	Date issued	Comment
June			
15		15	Pacific temperatures predict 98 run will be 1 day early similar to 96 timing. Record high water levels in the Nushagak this June in contrast to record low water in 97.
19			
20	31		
21	31		
22	30		
23	29		
24	29	24	Early age compositions from South Unimak and Port Moller indicate a preponderance of
25	29		3-ocean sockeye and a lack of age 2.2 sockeye which were 27-32% of preseason forecasts
26	29		
27	29		
28	31		
29	30	29	False Pass catches indicate a run similar to PM forecasts; however, sockeye to chum ratios
30	31		in PM catches indicate a smaller run. Lengths by age indicate a larger run but prediction
1	32		is likely unreliable.
2	32	2	PM catches similar to 87 & 88 when runs were 23 & 27 million; however, the 98 catch+
3	32		escapement lags well behind both of those years.
4	32	4	Based on inshore data thru 7/3 and PM age compositions, a forecast of 24 million with a 15 million catch was made. Actual run and catch more likely to be smaller than larger.
5	33	5	Early catch and escapements point to a small run if average timing; however no fishing in N/K and Nush districts thru 7/4 clouds our perception of run timing.
6	33	6	Runs appear to be late based on rate of increase in the PM catches from 6/12 to 7/5
7	34	7	Final district forecasts totaling 20 million with a 10.7 miliion catch was made relying on age compositions at PM and in the Bay and assuming run per index in 98 is close to 96
Final run = 18			Run timing was later than average
catch = 10			Run contained 54% 3-ocean and 4-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)
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
1997	ADF&G	22	31	25	20	53	47	33.6
	FRI	28	27	29	15	56	44	35.1
	False Pass	19	44	23	11	64	36	
	Port Moller	9	26	33	27	36	62	35.0
	BB Run	20	34	26	18	54	44	18.9
1998	ADF&G	25	32	24	18	57	43	30.2
	FRI	33	26	23	17	59	41	33.8
	False Pass	14	9	39	37	24	76	
	Port Moller	19	9	38	33	28	72	30.7
	BB Run	34	13	29	22	47	52	18.2

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. Average weights of sockeye in the Bristol Bay commercial catches, 1960–98.

	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
97	5.2	4.4	4.9	7.5	6.4	6.5	6.3	5.4	5.9	12	48	44
98	4.8	4.1	4.5	6.8	5.8	5.9	6.0	5.1	5.6	10	60	47
Means 85-97	5.2	4.6	4.9	7.3	6.2	6.6	6.2	5.4	5.8	27	51	51

Table 5. Forecasts of the 1999 Bristol Bay sockeye runs.

		Runs by age group (millions)								
River system	District	1.2	2.2	2-ocean	0.3	1.3	2.3	3-ocean	Total	Catch
Kvichak		5.2	7.4	12.6		1.2	0.4	1.6	14.2	
Naknek		0.4	0.8	1.2		1.2	0.6	1.8	3.0	
Branch		0.2	0.2	0.4		0.1	0.0	0.2	0.6	
	Naknek/Kvichak	5.8	8.4	14.2		2.5	1.0	3.5	17.7	8.5
	Egegik	0.6	4.7	5.3		1.1	1.3	2.4	7.7	6.4
	Ugashik	0.6	1.0	1.6		1.0	0.1	1.1	2.7	1.8
Wood		2.4	0.1	2.5		2.1	0.1	2.1	4.6	
Igushik		0.2	0.1	0.3		1.0	0.0	1.0	1.3	
Nush/Nuy		0.1	0.0	0.1	0.1	0.6	0.0	0.7	0.8	
	Nushagak	2.7	0.2	2.9	0.1	3.7	0.0	3.8	6.7	4.4
	Togiak	0.1	0.0	0.1		0.2	0.0	0.2	0.3	0.1
	Bristol Bay	9.8	14.3	24.1	0.1	8.5	2.4	11.0	35.1	21.2

Table 6. Bristol Bay sockeye runs by age group, 1958–98 and forecasts for 1999.

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	0.1	3.8	6.3	10.1	4.8	3.4	8.3	0.4	18.9	12
98	0.2	6.2	2.3	8.6	5.3	4.1	9.4	0.1	18.3	10
99		**9.8**	**14.3**	**24.1**	**8.5**	**2.4**	**11.0**		**35.1**	**21**
Means 1987-98	0.1	6.5	14.4	21.0	9.8	7.2	17.5	0.3	38.9	27

Table 7. Kvichak sockeye salmon statistics for forecasting 1999 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	.21	.62	1.1	517
93	4.05	69	210	6.2	.001	.79	.84	1.63	0.8	518
94	8.34	94	277	6.5	.003	1.75	**1.23**			506
95	10.04	87	269	6.6	.017	**5.20**				

(1) 99 forecast of age 1.2 from return of age 1.1 (.017) and regression of age 1.2 on age 1.1 for 1974-94.
R^2= .48 Y= 2.0 + 189 (age 1.1)
(2) 99 forecast of age 1.3 from return of age 1.2 (1.75) and regression of age 1.3 on age 1.2 for 1981-93.
R^2= .72 Y= 0.6 + .33 (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
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	.16	.83	2.8	522
92	4.73	77	11	9.8	.002	.51	.14	.65	5.9	533
93	4.03	69	96	11.3	.001	.59	**.36**			520
94	8.34	94	94	10.7	.029	**7.40**				

(1) 99 forecast of age 2.2 from age 2 smolt (94) and return of age 2.1 (.029) and multiple regression for 1981-93.
R^2= .93; F2,10= 62.6 Y= .023(age 2 smolt) + 154.6 (age 2.1) - .05
(2) 99 forecast of age 2.3 from return of age 2.2 (.59) and regression of age 2.3 on 2.2 for 1981-92.
R^2= .67 Y= .102 (age 2.2) + 0.3

Table 8. 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	.33	6.19	484	491
92	1.61	28	33		.000	.25	.52	.001	.23	.32	1.32	460	503
93	1.54	21			.000	.27	1.27	.011	.44	**.60**		486	480
94	.99	65			.006	.48	**1.20**	.015	**.79**			464	
95	1.11	59			.009	**.38**							

(1) 99 forecast of age 1.2 from recent 5-year average (.38)
(2) 99 forecast of age 1.3 from retrun of age 1.2 (.48) and escapement (.99)
R^2= .92; F2,10= 60.6 Y= 3.11(age 1.2) + 1.22(escape.) -1.50
(3) 99 forecast of age 2.2 from return age 2.1 (.015) and regression of age 2.2 on 2.1
R^2= .42 Y= 23.04(age 2.1) + .44
(4) 99 forecast of age 2.3 from recent 5-year average (.60)

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	.00	.57
92	.22	75	.002	.09	.07	.000	.06	.01	.23
93	.35	76	.004	.12	.14	.000	.08	**.04**	
94	.24	84	.001	.15	**.14**	.002	**.16**		
95	.22	83	.004	**.16**					

Table 9. Egegik sockeye salmon statistics for forecasting 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
81	0.69	71	2	9.5	.000	.52	.95	1.47	73.5	519
82	1.03	88	17	10.1	.002	1.01	1.79	2.80	16.5	510
83	0.79	88	55	10.4	.002	1.72	2.69	4.41	8.0	509
84	1.17	69	14	9.0	.001	.58	.93	1.51	10.8	502
85	1.10	67	4	11.6	.000	.54	1.33	1.87	46.8	511
86	1.15	74	36	10.2	.002	1.76	3.59	5.35	14.9	483
87	1.27	54	72	8.9	.000	.86	4.34	5.20	7.2	496
88	1.61	57	4	9.6	.001	.40	1.43	1.83	45.7	472
89	1.61	58	5	10.3	.000	.59	.43	1.02	20.4	522
90	2.19	70	6	9.7	.000	.40	.84	1.24	20.7	480
91	2.79	56	20	9.3	.001	1.33	3.87	5.20	26.0	502
92	1.94	63	55	9.7	.000	.32	1.04	1.36	2.5	508
93	1.52	44	7	9.3	.002	.46	.53	0.99	14.1	502
94	1.90	70	22	10.5	.008	.36	**1.14**			484
95	1.27	76	12	9.2	.007	**.57**				

(1) 99 forecast of age 1.2 fromrecent 5-year average (.57)
(2) 99 forecast of age 1.3 from number of age 1 smolt (22) and return age 1.2 (.36)
R^2= .68; F2,10= 10.5 Y= .09 + .023(age 1 smolt) + 1.51(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	0.70	71	32	12.2	.060	3.30	1.39	4.69	14.7	528
82	1.03	29	11	16.8	.012	1.74	1.59	3.33	30.3	529
83	0.79	88	30	15.7	.007	3.03	2.61	5.64	18.8	520
84	1.17	69	45	14.1	.083	6.17	4.74	10.91	24.2	524
85	1.10	67	13	14.3	.031	4.17	1.22	5.39	41.5	498
86	1.15	74	27	15.4	.010	3.79	4.21	8.00	29.6	502
87	1.27	54	52	14.5	.064	8.41	10.73	19.20	36.9	492
88	1.61	58	89	15.6	.063	10.24	5.48	15.78	17.7	520
89	1.61	54	18	12.4	.034	5.98	3.92	9.90	55.0	488
90	2.19	70	38	12.2	.065	9.28	4.61	13.89	36.6	512
91	2.77	56	39	13.7	.020	2.98	2.49	5.47	14.0	520
92	1.95	65	50	11.6	.053	4.51	2.80	7.36	14.7	502
93	1.52	44	8	16.1	.029	0.84	**1.26**			502
94	1.90	70	15	13.7	.065	**4.68**				

(1) 99 forecast of age 2.2 from age 2 smolt (15) and return of age 2.1 (.065)
R^2= .57; F2,10= 9.1 Y= .78 + .068(age 2 smolt) + 44.3(age 2.1)
(2) 99 forecast of age 2.3 from return of Y= .25 + .672(age 2.2)
R^2= .50

Table 10. Ugashik sockeye salmon statistics for forecasting 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
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	8.6	504
92	2.17	49	24	6.7	.003	.18	.54	0.72	3.0	498
93	1.41	48	7	7.8	.002	.24	.32	0.56	8.0	490
94	1.08	79	1	9.9	.011	.32	**.99**			488
95	1.30	80	14	7.8	.018	**.60**				

(1) 99 forecast of age 1.2 from recent 5-year average (.60)

(2) 99 forecast of age 1.3 from age 1.2 (.32) and mean length of age 1.2 (488)
R^2= .80; F2,10= 20.3 Y= 17.99 + 1.77(age 1.2) - .036(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
79	1.70	53			.008	1.39	.52	1.91		502
80	3.32	59	13	13.3	.039	3.19	.78	3.97	30.5	520
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	.30	.87	14.5	512
92	2.17	49	15	11.1	.004	.88	.74	1.62	10.8	506
93	1.41	48	1	13.5	.006	.23	**.13**			508
94	1.08	79	1	12.7	.012	**.99**				

(1) 99 forecast of age 2.2 from age 2.1 (.012) and number of age 2 smolt (1)
R^2= .80; F2,9= 17.7 Y= .39 + 48.4(age 2.1) + .019(age 2 smolt)

(2) 99 forecast of age 2.3 from average ratio of 2.3 on 2.2
R^2 = .70 Y= .55(age 2.2)

Table 11. 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	.07	5.08	496
92	1.29	73	9.1	6.5	.001	2.32	.09	1.60	.05	4.06	495
93	1.18	59	7.5	7.6	.000	1.67	.13	.98	**.08**		491
94	1.47	52	8.7	6.8	.010	2.77	**.11**	**2.07**			488
95	1.48	73	7.1	8.0	.005	**2.40**					

(1) 99 return of age 1.2 from return age 1.1 (.005) and percent age .2 in escapement (73)
R2= .74; F2,11= 14.1 Y= 148.7(age 1.1) + .024(%age .2 esc.) - .09
(2) 99 forecast of age 1.3 was from return age 1.2 (2.77) and percent age .2 in escapement (52)
R2= .78: F2,10= 18.0 Y= 1.43 + .635 (age 1.2) - .019(%age .2 esc)
(3) 99 return of age 2.2 from recent 5-year average (.11)
(4) 99 return of age 2.3 from return of 2.2 and regression of 2.3 on 2.2
R2= .48 Y= .027 + .40(age 2.2)

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	1.64	507
92	.31	26	9.1	6.5	.04	.01	.13	.02	.20	517
93	.41	31	7.5	7.6	.12	.02	.29	**.03**	.46	507
94	.45	27	8.7	6.8	.24	**.05**	**1.03**			488
95	.47	30	7.1	8.0	**.17**					

(1) 99 returns of age 1.2 and 2.2 from recent 5-year averages.
(3) 99 return of age 1.3 from mean length of age 1.2 (488) and percent age .2 in escapement (27)
R2= .47; F2,10=4.4 Y= 12.39 - .022(ML age 1.2) - .012(%age .2 esc)
(4) 99 returns of age 2.3 from return age 2.2 (.01) and regression of 2.3 on 2.2
R2= .51 Y= .02 + .859(age 2.2)

Table 12. 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	.12	1.43	461	569
92	.70	31	.08	.49	.01	.22	.59	.05	1.44	486	563
93	.72	11	.04	.03	.00	.06	.68		.81	474	546
94	.51	6	.00	.04		.08	**.60**			456	
95	.28	39	.00	**.09**		**.11**					
96	.50	18									

(1) 99 returns of age 1.2 from recent 5-year average.
(2) 99 forecast of age 0.3 from return of age 0.2 (0)
R^2= .66 Y= .09 + 6.48(age 0.2)
(3) 99 forecast of age 1.3 from return of age 1.2 (.08) and regression of return 1.3 on 1.2
R^2= .42 Y= .31 + 3.64(age 1.2)

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	.11	.74	504	572
87	.28	39	.000	.01	.19	.53	.03	.08	.84	514	567
88	.31	73	.001	.01	.11	.39	.03	.05	.59	515	592
89	.10	3	.000	.04	.12	.31	.01	.04	.52	522	561
90	.19	24	.001	.02	.10	.43	.07	.04	.66	495	570
91	.28	41	.001	.00	.18	.42	.03	.03	.66	516	589
92	.20	23	.001	.03	.05	.11	.03	.03	.25	525	581
93	.19	24	.000	.00	.06	.25	.01	**.03**		512	561
94	.17	45	.000	.00	.04	**.18**	**.03**			515	
95	.18	36	.000		**.09**						

(1) 99 forecasts of ages 1.2 and 2.2 from recent 5-year averages
(2) 99 forecast of age 1.3 from return age 1.2 (.04) and regression of return of 1.3 on 1.2
R^2= .82 Y= .077 + 2.60(age 1.2)
(4) 99 forecast of age 2.3 from
R^2= .51 Y= .02 + .859(age 2.2)