FRI-UW-9213
October 1992

FORECASTS OF THE 1993 SOCKEYE SALMON RUNS TO BRISTOL BAY

DONALD E. ROGERS
RESEARCH PROFESSOR

A Report to the
Pacific Seafood Processors Association

ACKNOWLEDGMENTS

To provide predictions this early (October) requires the use of much preliminary data collected from the 1992 run. It was only with the help of Mr. Barry Stratton and Mr. Drew Crawford (ADFG, Anchorage) that forecasts could be made at this time.

KEY WORDS

Bristol Bay catches, fishery, forecast, Port Moller, sockeye salmon

INTRODUCTION

Salmon runs are characterized by large year to year variation in number; to an even larger extent, this variation is passed on to the annual catch because escapement requirements have priority. During the past 20 years, the annual sockeye (*Oncorhynchus nerka*) salmon catches in the major Alaskan fisheries have all had the largest catch at least 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 1 million fish in 1973 to nearly 40 million fish just 10 years later. The relative variation in catch from year to year is even greater within the fishing districts of Bristol Bay (Fig. 2). Most fishermen and processors do not operate in all districts; in addition, the fisheries are managed on a district or within-district basis. This year-to-year variation poses problems for the fishing industry because of the great deal of uncertainty in preparations for the harvesting, processing, transportation and sale of the salmon. 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, and 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 (ADFG) 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. 3). 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 ADFG. This report presents a review of the 1992 season and forecasts of the 1993 sockeye salmon runs to Bristol Bay, which are based mostly on statistics provided by ADFG.

REVIEW OF THE 1992 RUN

FORECASTS AND ACTUAL RUNS

The FRI prediction of total run to Bristol Bay in 1992 was 33 million with a 22 million catch, whereas ADFG predictions were 37 and 26 million, respectively (Table 1). The ADFG forecasts resulting from their statistical analyses were increased by about 35% to adjust for a recent tendency to underforecast the runs (Geiger and Savikko 1992). Therefore their database for the 1992 forecast actually indicated a lower run than forecast by FRI. The 1992 run and catch were higher than both forecasts (45 and 32 million), and the main cause was an unexpected record run to Egegik and larger than normal returns of the older age groups (3- and 4-ocean) to all systems (Table 2).

The catch of 32 million was 45% greater than we predicted and was thus the second largest error in our forecasted catches since 1985. For the past 8 years, the catches have differed from our forecasts by an average of 31% (range: 5% to 74%) and from the ADFG forecasts by an average of 46% (range: 16% to 125%). For comparison, the sockeye catches in the Chignik and Upper Cook Inlet fisheries in the same years (1985-92) differed from ADFG forecasts by averages of 33% and 61%, respectively. The average error in forecasts of pink (*O. gorbuscha*) salmon catches in major Alaskan fisheries has been greater than that for sockeye except for Kodiak (34%; range 5% to 64%).

In addition to the pre-season forecasts, we have made in-season forecasts each year since 1987 from a test-fishing program in the vicinity of Port Moller. This project, which was originally operated by ADFG (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. Very early in 1992 (about June 20) the test boat catches indicated that the run was going to be larger than forecast and the June 30 forecast turned out to be exactly right—45 million (Table 3). The Port Moller samples also provided an accurate estimate of the age composition in the 1992 run, which was somewhat useful in predicting where in Bristol Bay the 45 million sockeye would be distributed (Table 4).

The timing of the 1992 runs to the fishing districts has not yet been calculated by matching up daily escapements with catches; however, the timing of the separate escapements and catches indicated average timing in 1992. The fish arrived early at Port Moller, but these early fish appeared to take longer than usual to reach the fishing districts. Temperatures during the winter of 1991-92 were colder than average in Bristol Bay but warmer than average at sea (Fig. 4). There was an early spring in Bristol Bay and water temperatures in the North Pacific were also above average in the spring of 1992 (Fig. 5). With this information, we had anticipated that run timing would be early or average; however water temperatures off Port Moller were much colder than average during June and this may explain why the timing appeared early off Port Moller but about average in Bristol Bay.

THE FISHERIES

After the first commercial openings in late June (25-30) it was obvious that Egegik was going to have a 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, where relatively large catches were made on June 25 and 27; however, on July 5 a daily catch record was set for Bristol Bay when 3.2 million sockeye salmon were caught: 1.7 million from the Naknek/Kvichak, 1.2 million from Egegik, and 0.3 million from the Nushagak. The daily record for Egegik was set on July 10 (1.4 million).

The timing of the 1992 fisheries was about average except at Ugashik, where fishing was greatly restricted until after July 5 (Tables 5 and 6). This delayed fishing, which eventually contributed to an over-escapement, was apparently caused by an underestimation of fish in the fishing district and late arrival at the counting tower. The 32 million catch in 1992 was the third largest in the history of Bristol Bay; however given the size and distribution of the run among the districts, an additional 3 million fish could have been caught and processed if there had been a little more early-season fishing time. Although the runs to Egegik and Ugashik were above average in 1992, there was less than average fishing time permitted (Table 7).

FISH SIZE

In 1991, the sockeye salmon returning to Bristol Bay were much smaller than average (by age and sex), which prompted some concern that we might under-forecast the return of 3-ocean fish in 1992 (Fig. 6). This not only happened, but we also saw the largest run of 4-ocean sockeye in the history of Bristol Bay; 1.1 million that were unpredicted for 1992. These were fish that normally should have returned after 3 years at sea but had apparently not attained enough growth to mature until their fourth year. Small size of sockeye salmon in the Bristol Bay run is usually caused by poor growth in the spring of the year of their return, and is probably a direct result of competition for food as the sockeye salmon are concentrated during their homeward migration. In past years, small size (length or weight) has been associated with large runs and/or cold spring temperatures, whereas large size has occurred when runs were small or water temperatures were warm.

The poor growth attained in the spring of 1992 (or possibly earlier) resulted in an unusually small average weight of 5.5 lbs for a catch that contained a majority of 3-ocean fish (Table 8). An average weight of over 6 lbs would be typical for a catch with 58% 3-ocean fish and 55% males. The small size of the 2-ocean fish, especially the females, also contributed to some of the over-escapement that occurred in 1992 as many of these fish were too small to be gilled.

ESCAPEMENTS

The Bristol Bay runs are managed by regulating fishing to achieve escapement goals for each major river system. The fixed escapement goals (mid-point and range), which should produce the largest average catch in the future, are estimated from curvilinear relationships between past

escapements and the returns they produced. The Kvichak runs are not managed for a fixed goal but instead for an escapement within a range of 4-10 million that depends on escapements in previous years. The escapement goals in effect in 1992 were established in 1984, and since then there has been a tendency to obtain escapements greater than the mid-point goals (Fig. 7). This pattern was continued in 1992, when every system except the Kvichak received an escapement greater than the mid-point goal. The sum of all escapements in excess of the mid-point goals totaled 3.4 million, while escapements in excess of the upper range of the goals totaled 2.3 million. These fish represent a loss of production in 1992 but probably no loss to future production, except perhaps at Egegik and Ugashik, where escapements were near 2 million.

FORECASTS FOR 1993

The statistics used to forecast the Bristol Bay sockeye salmon runs come from several sources: (1) the numbers, ages, lengths, and weights of adult salmon in the catches and escapements and smolt in the seaward migrations are from annual reports by ADFG, e.g., Stratton (1991) and Woolington et al. (1991); (2) distributions of spawners in the Wood River lake system are from joint FRI and ADFG surveys and presented in FRI annual reports e.g., Rogers et al. 1990; (3) the relative numbers, ages, and lengths of fry in the Wood River and Kvichak lake systems are from annual reports by FRI, e.g., Rogers et al. (1992); (4) air temperatures for Bristol Bay are from monthly reports by the U.S. Weather Bureau; and (5) coastal sea surface temperatures at Kodiak and Adak are from monthly reports by 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 1993, we assembled all relevant statistics from past brood years (since 1973) and submitted them 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 1993 run. Only adult returns since 1978 (1973 brood year) were used because of an obvious increase in the relative production (return per escapement) in the brood years of the early to mid-1970s (Fig. 8) and temperatures have generally been warmer since 1977 than in earlier years (Figs. 4 and 5).

The forecast of the total 1993 Bristol Bay sockeye salmon run is 43.3 million with a predicted catch of 31.9 million (Table 9). This forecast does not include 4-ocean fish except in the Nushagak, which had less than half of the 1.1 million in 1992 that followed a run of 25.4 million 3-ocean fish in 1991 (Table 10). The 1992 run of 3-ocean fish was also large at 22.5 million; therefore, we might expect up to 0.5 million additional 4-ocean sockeye salmon in Bristol Bay in 1993. Over the past 3 years, there have been large runs of 3-ocean fish, especially relative to the returns of 2-ocean fish in the preceding years (Fig. 9). Therefore, we are probably more likely to

under-forecast than over-forecast the 3-ocean returns in 1993. The total returns of jacks (1-ocean) to Bristol Bay in 1992 predicts a run of 22.4 million 2-ocean fish in 1993, which is close to the forecast obtained by summing the individual river system forecasts (24.4).

The sockeye salmon runs and our forecasts, past and present, for the four major districts in Bristol Bay are shown in Figure 10. Egegik and Ugashik are predicted to have 1993 runs similar to the 1992 runs, whereas the Naknek/Kvichak is predicted to have a somewhat smaller run and the Nushagak a somewhat larger run than in 1992. Runs to the Naknek/Kvichak over the past 8 years differed from our forecasts by an average of 43%, with 5 runs larger and 3 runs smaller than predicted. The runs to Egegik have all been larger than the predictions with an average error of 39%, whereas the runs to Ugashik have been equally above and below the forecasts with an average error of 35%. The runs to the Nushagak have been closest to our predictions with an average error of only 22% (comments on individual river system forecasts follow). 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. 11).

NAKNEK/KVICHAK

About 9 million sockeye salmon are expected to return to the Kvichak in 1993, which would be a rather modest run but considerably larger than the small off-cycle runs of the past. The 1992 run was 10 million. All four age groups are expected to contribute to the run in 1993, but age 2.2 fish will likely be most numerous (Table 11). The run of this age group was predicted from the return of jacks (age 2.1) and the mean weight of smolt (small weight=large return and large weight=small return). The average weight of age 2. smolt is inversely related to abundance and happened to be more closely related to adult returns than the number of smolt. We are forecasting a relatively large return of age 2.3 fish to the Kvichak (1.3 million) on the basis of the average length of age 2.2 fish in the 1992 escapement and that, in past years, small age 2.2 fish have been associated with large returns of age 2.3 while large age 2.2 fish have been associated with small returns of age 2.3 fish.

The Naknek run in 1993 is expected to be 3.6 million with a majority of 3-ocean fish (Table 12). The most numerous age group, age 2.3, was forecast from the return of age 2.2 in 1992 and the ocean age composition of parent spawners (percent age .2). The more 2-ocean fish in the parent year the smaller the return of 3-ocean fish (an indication that ocean age is partially inherited). The Naknek had a large return of age 1.4 in 1992 (350,000) that followed an enormous run of age 1.3 in 1991 of nearly 7 million. The 1992 run of age 1.3 to Naknek was only 1.2 million, thus we would not expect as large a run of 4-ocean fish in 1993 as occurred in 1992.

EGEGIK

The number of smolt was a significant measurement in each of the four age group predictions for Egegik (Table 13). Since smolt outmigration estimates are only available after 1982, the forecast

database for Egegik is rather small: 8-9 years. Of the predicted large run in 1993 of 18.2 million, 11 million were predicted for age 2.2. This prediction carries a great deal of uncertainty because it is based on a smolt estimate (89 million) that is greater than any previous estimate. However, there was also a relatively large return of age 2.1 jacks to Egegik in 1992 and that would also point to a large run of age 2.2 in 1993. The next most numerous age group in the predicted 1993 run to Egegik was fish of age 2.3 (5.7 million). Four variables—parent escapement, number of age 2. smolt, return of age 2.2, and the average length of age 2.2 fish—explained a remarkable 99% of the variation in the past runs of age 2.3 sockeye salmon to Egegik. Thus, the 1993 forecast of this age group is very precise and we hope it will be very accurate.

UGASHIK

The 1993 run to Ugashik (5.5 million) is expected to come from each of the major age groups with no single age group especially numerous (Table 14). Although smolt estimates were available, they were not as well correlated with returns as the smolt estimates for Egegik, and number of smolt was only used with the return of age 2.1 jacks to predict the 1993 run of age 2.2 to Ugashik (1.5 million). The return of age 1.1 jacks and the mean lengths of 2-ocean fish were used to predict the other age groups from the longer database (Table 15). In past years, large runs of 3-ocean fish were associated with small 2-ocean fish, and small runs of 3-ocean fish were associated with large 2-ocean fish in the previous year. The 2-ocean sockeye salmon in the Ugashik escapement in 1992 were among the shortest ever; therefore, we can expect larger than average runs of 3-ocean fish in 1993, and 2.5 million are predicted.

NUSHAGAK

The Wood River system is expected to produce nearly half of the 6 million run projected for the Nushagak in 1993. Most of the predicted Wood River run of 2.8 million should come from age 1.3 fish (1.8 million) because the parent spawners were mainly 3-ocean fish, and yet there was a large return of age 1.2 fish in 1992 (1.6 million). The run of age 1.2 fish in 1993 is not expected to be very large (0.9 million) because the parent escapement was unevenly distributed among the Wood River Lakes and contained only 49% 2-ocean fish (Table 16). The distribution of the escapement is calculated by squaring the difference between the percentage distribution of the escapement in the lakes and the percentages that the lakes constitute of the total system surface area. Small values indicate a very even distribution and large values an uneven distribution. The 1988 escapement was evenly distributed among the lakes (3), whereas the 1989 escapement was unevenly distributed (12).

The Igushik system is expected to have an above-average run in 1993 (1.6 million) that will come mostly from the return of age 1.3 fish from the 1988 brood year (1.4 million). The spawners in 1988 were mostly 3-ocean fish (88%), the return of age 1.2 fish in 1992 of 190,000 was high relative to the age of parent spawners, and these age 1.2 fish were much smaller than average. These three factors point towards a larger-than-average age 1.3 return in 1993.

The statistics on the Nushagak/Nuyakuk sockeye salmon runs are not as accurate as those for the other Bristol Bay systems because sampling for numbers and ages in the escapement has not been carried out consistently. The Nushagak River system contains most of the freshwater age 0 sockeye salmon in Bristol Bay and, along with the Nuyakuk (Tikchik Lakes) system, often has significant returns of 4-ocean fish (Table 17). Average returns of these age groups are predicted for 1993.

TOGIAK

The predicted run of 0.5 million to Togiak in 1993 contains, as usual, a majority of 3-ocean fish. The return of age 1.3 sockeye salmon in 1993 (350,000) was predicted from the return of age 1.2 fish (110,000) in 1992 and a linear regression (Table 17).

LITERATURE CITED

Geiger, H. J. and H. Savikko. 1992. Preliminary forecasts and projections for 1992 Alaska salmon fisheries and review of the 1991 season. ADFG Region. Inform. Rep. No. 5J92-05. 74 p.

Rogers, D.E., B. Rogers, G. Ruggerone, D. Helton, L. Paterson and M. Zimmermann. 1990. Alaska salmon research. Ann. Rep.–1989 to Pacific Seafood Processors Association. Univ. Washington, Fish. Res. Inst., FRI-UW-9002. 31 p.

Rogers, D. E., T. Quinn, B. Rogers, G. Ruggerone, B. Berejikian, L. Patterson and K. Work. 1992. Alaska salmon research. Ann. Rep.–1991 to Pacific Seafood Processors Association. Univ. Washington, Fish. Res. Inst., FRI-UW-9201. 30 p.

Stratton, B.L. 1991. Abundance, age, sex and size statistics for Pacific salmon in Bristol Bay, 1990. ADFG Tech. Fish. Rep. 91-15. 153 p.

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

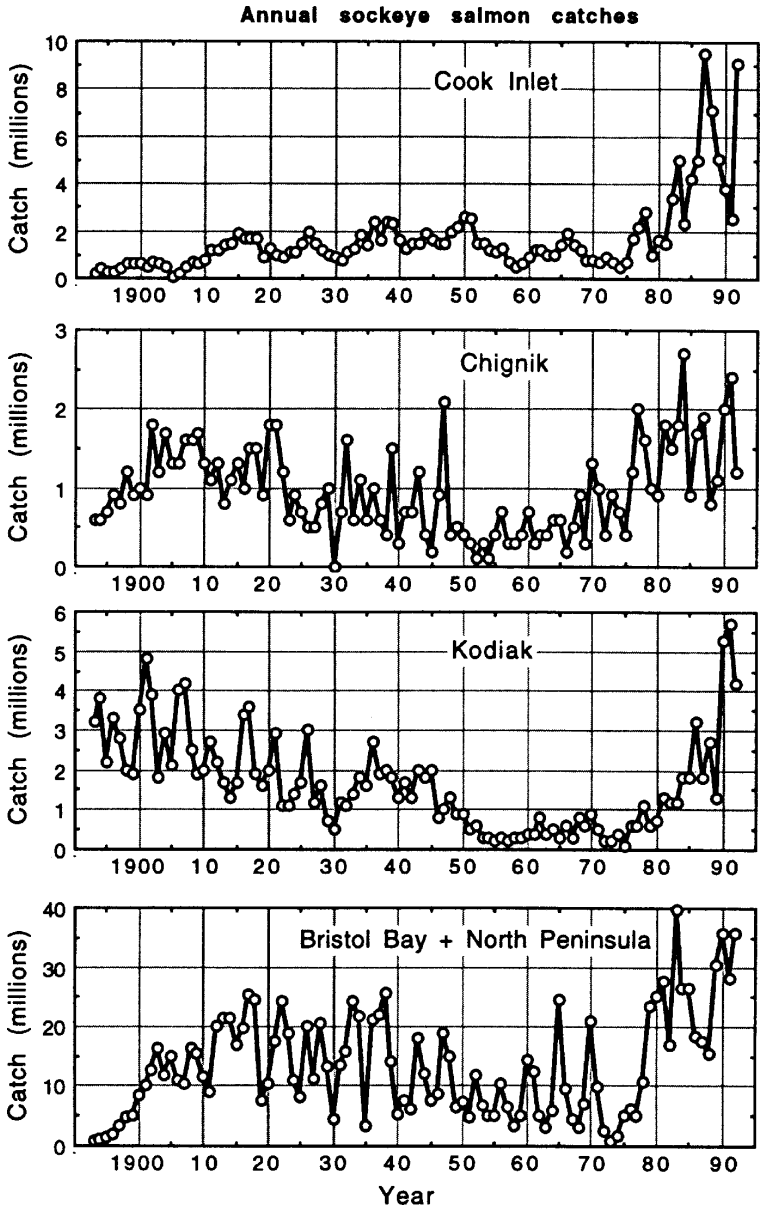

FIGURE 1. Annual commercial catches of sockeye salmon in the major Alaskan fisheries, 1893–1992.

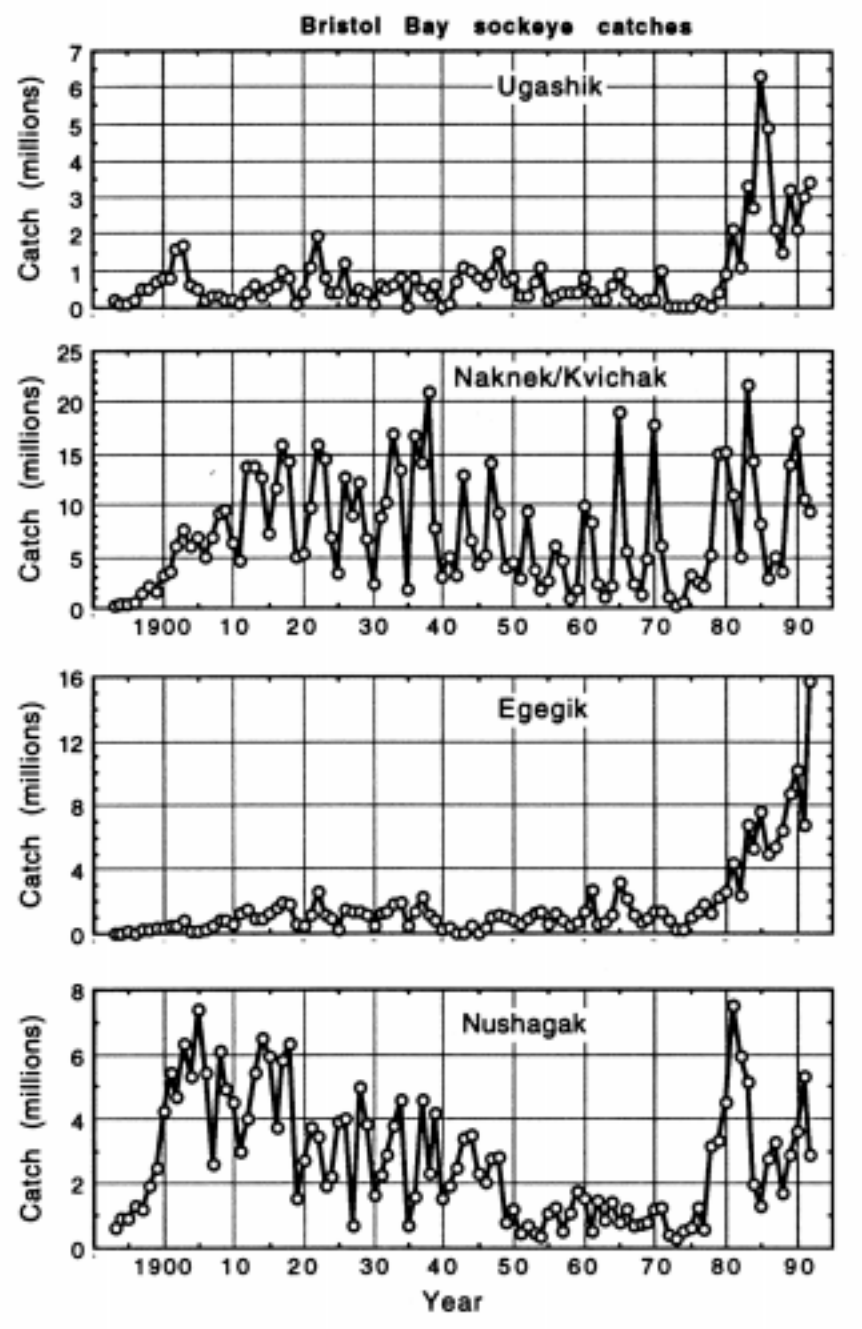

FIGURE 2. Annual commercial catches of sockeye salmon in the four main fishing districts in Bristol Bay, 1893–1992.

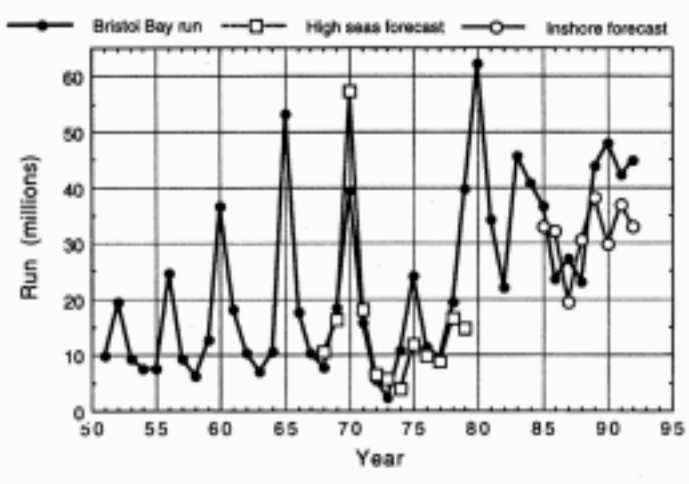

FIGURE 3. Annual runs of sockeye salmon to Bristol Bay, 1951–92, with pre-season forecasts from high seas sampling (1968–79) and inshore statistics (1985–92).

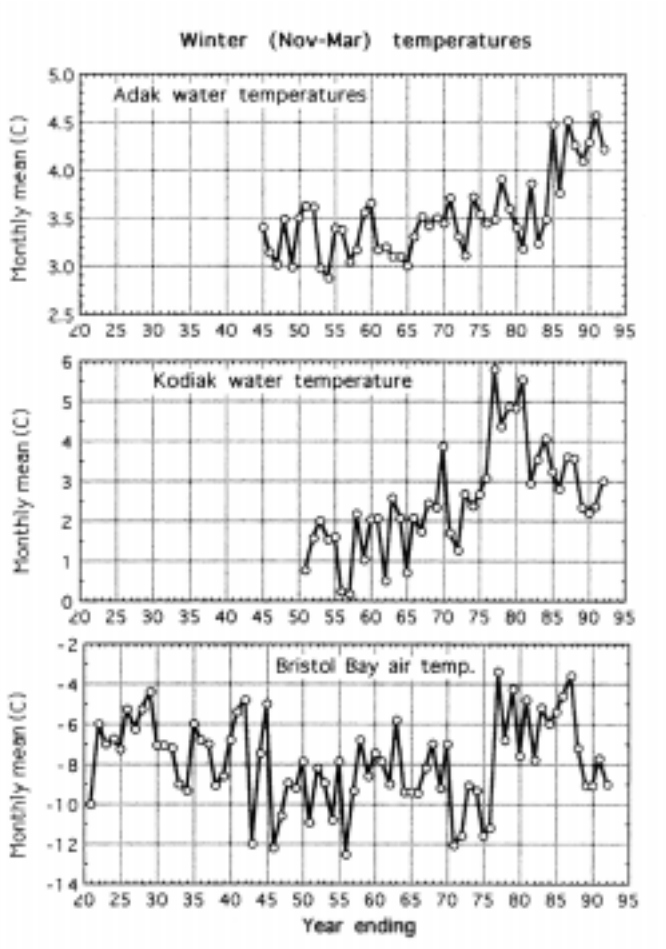

FIGURE 4. Average winter air temperatures for Bristol Bay (Dillingham and King Salmon) and sea surface temperatures at Kodiak (Gulf of Alaska) and Adak (Aleutian Islands).

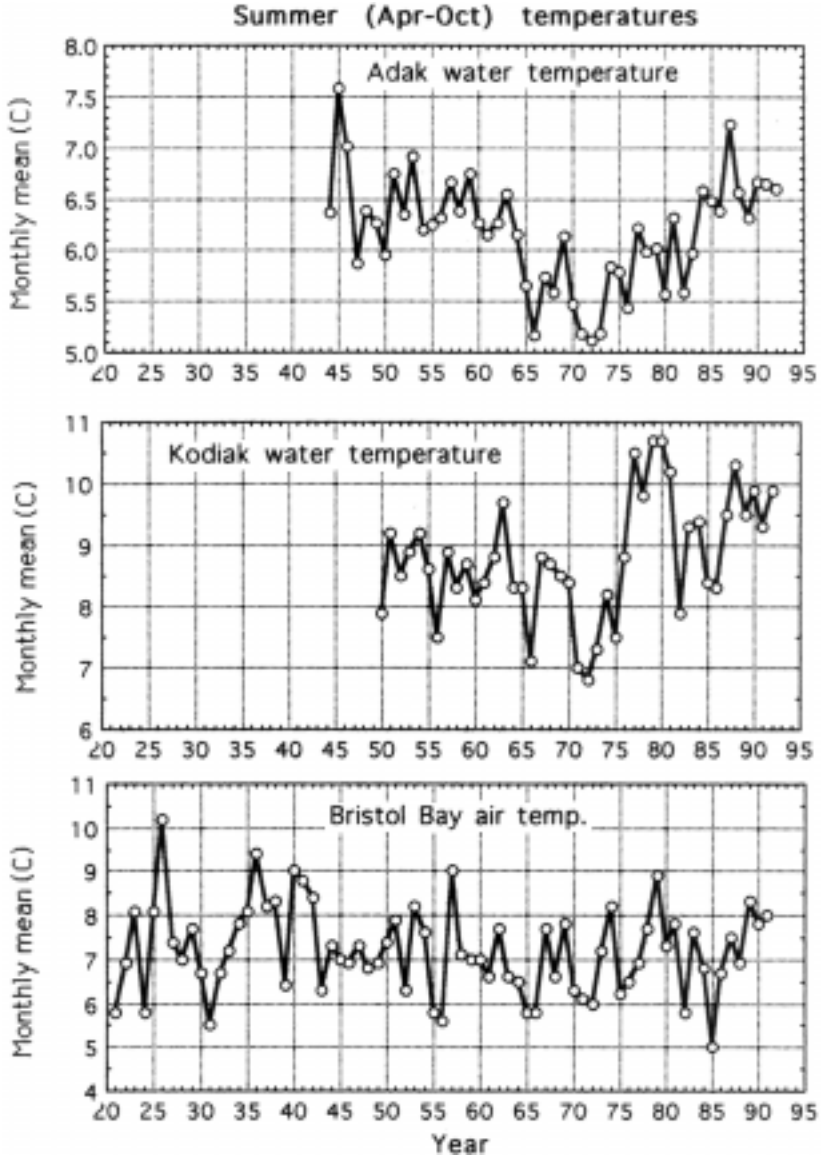

FIGURE 5. Average summer air temperatures for Bristol Bay (Dillingham and King Salmon) and sea surface temperatures at Kodiak (Gulf of Alaska) and Adak (Aleutian Islands).

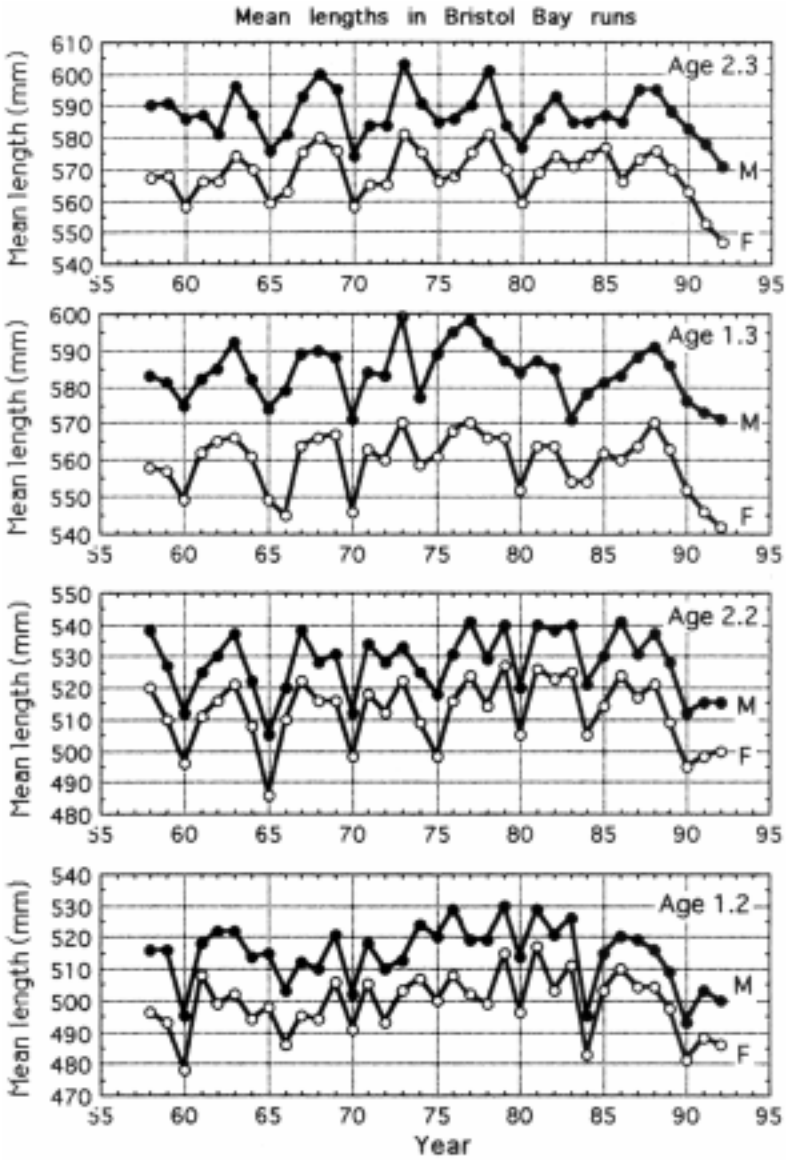

FIGURE 6. Annual mean lengths (mid-eye to tail fork) by age and sex for sockeye salmon in the Bristol Bay runs, 1958–92.

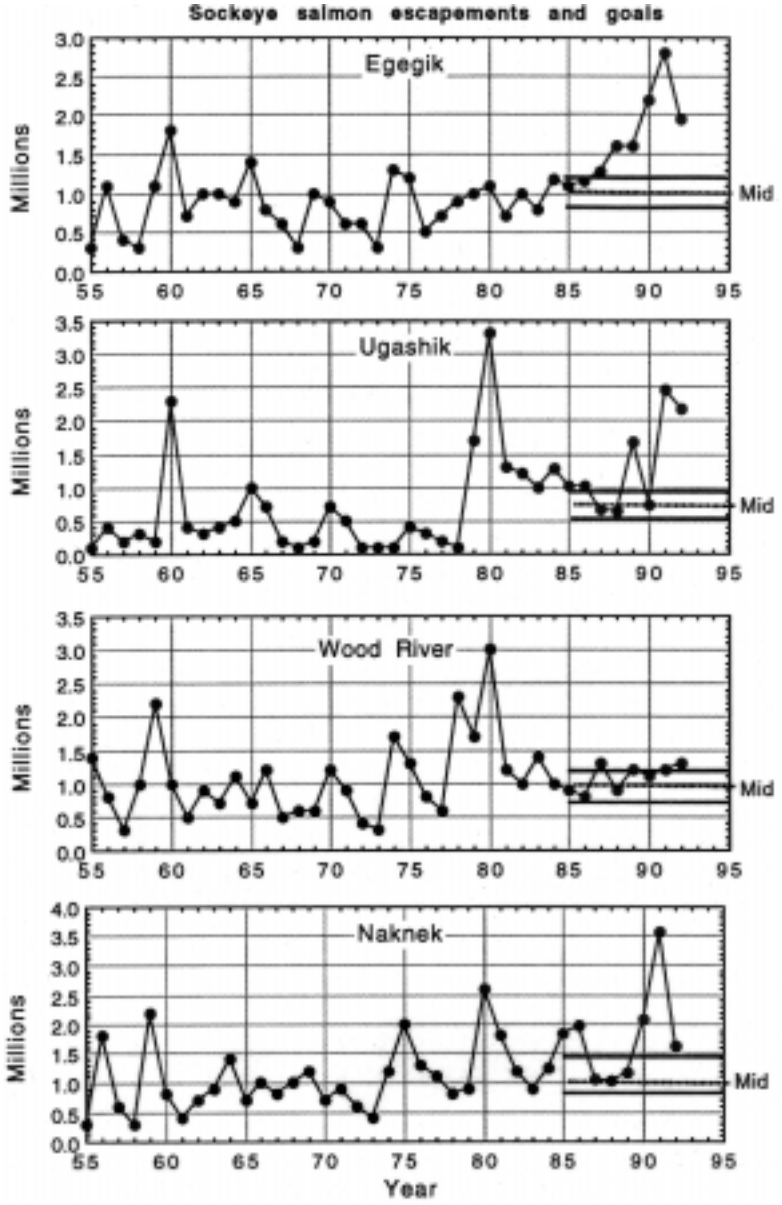

FIGURE 7. Sockeye salmon escapements to four river systems in Bristol Bay, 1955–92, and the range and mid-point of management goals since 1985.

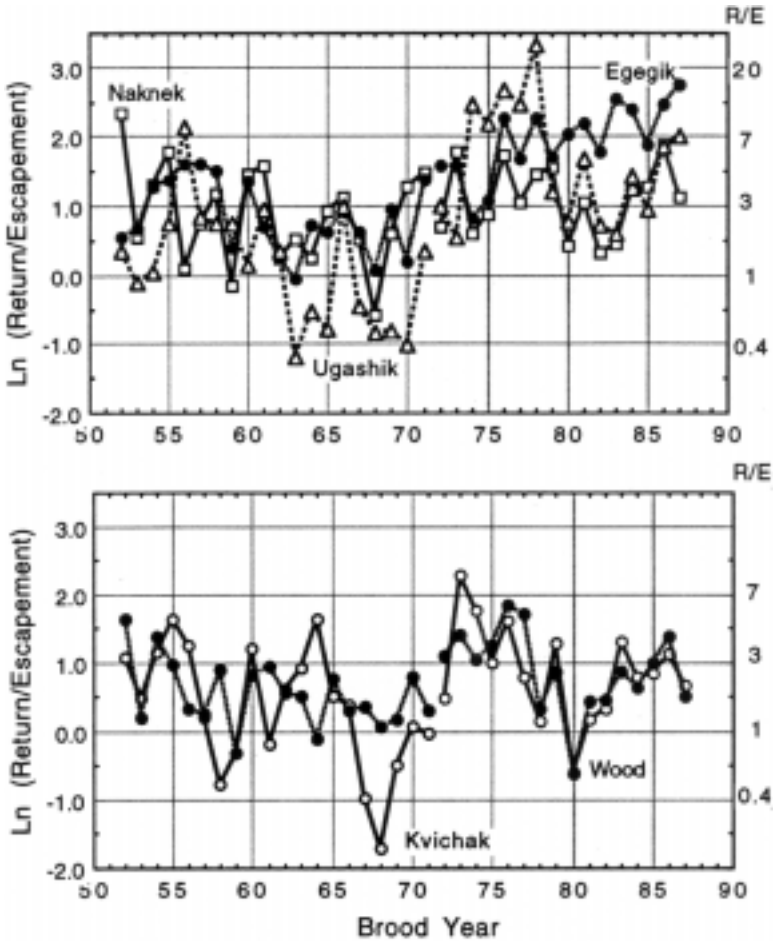

FIGURE 8. Number of sockeye returning per sockeye in the parent escapement (relative production) plotted on a logarithmic scale for five Bristol Bay river systems, 1952–87 brood years.

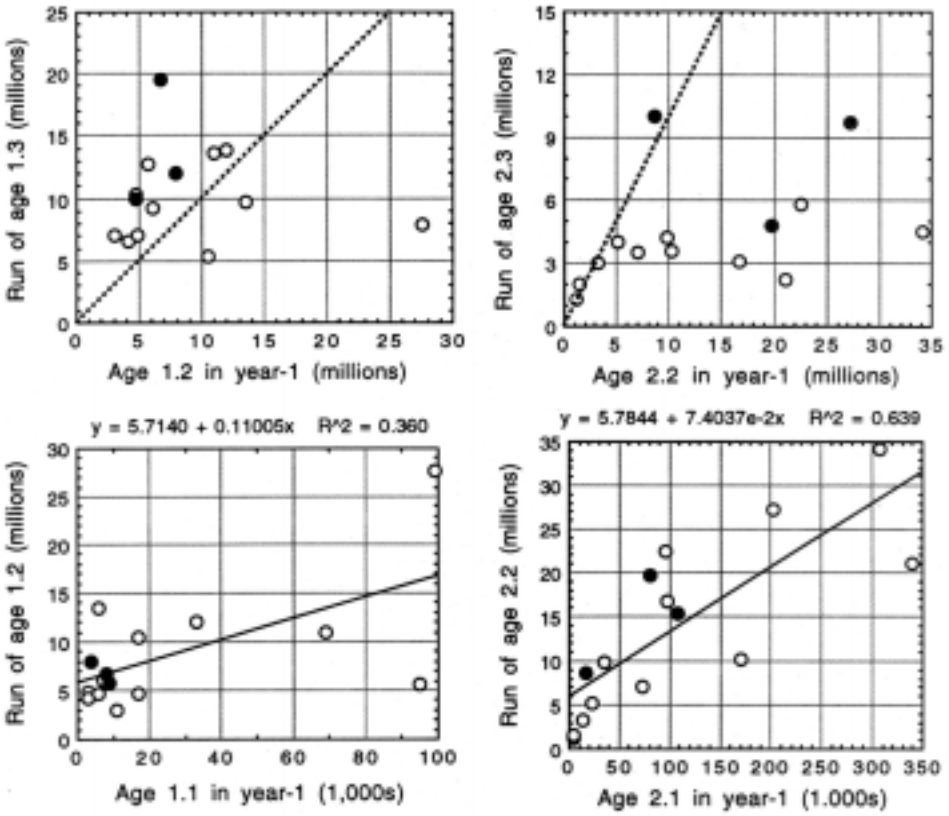

FIGURE 9. Plots of the runs by freshwater age of 2- and 3-ocean-aged sockeye salmon on the runs of 1- and 2-ocean-aged fish the previous year for the combined Bristol Bay runs, 1979–92 (solid points for the runs in 1990–92).

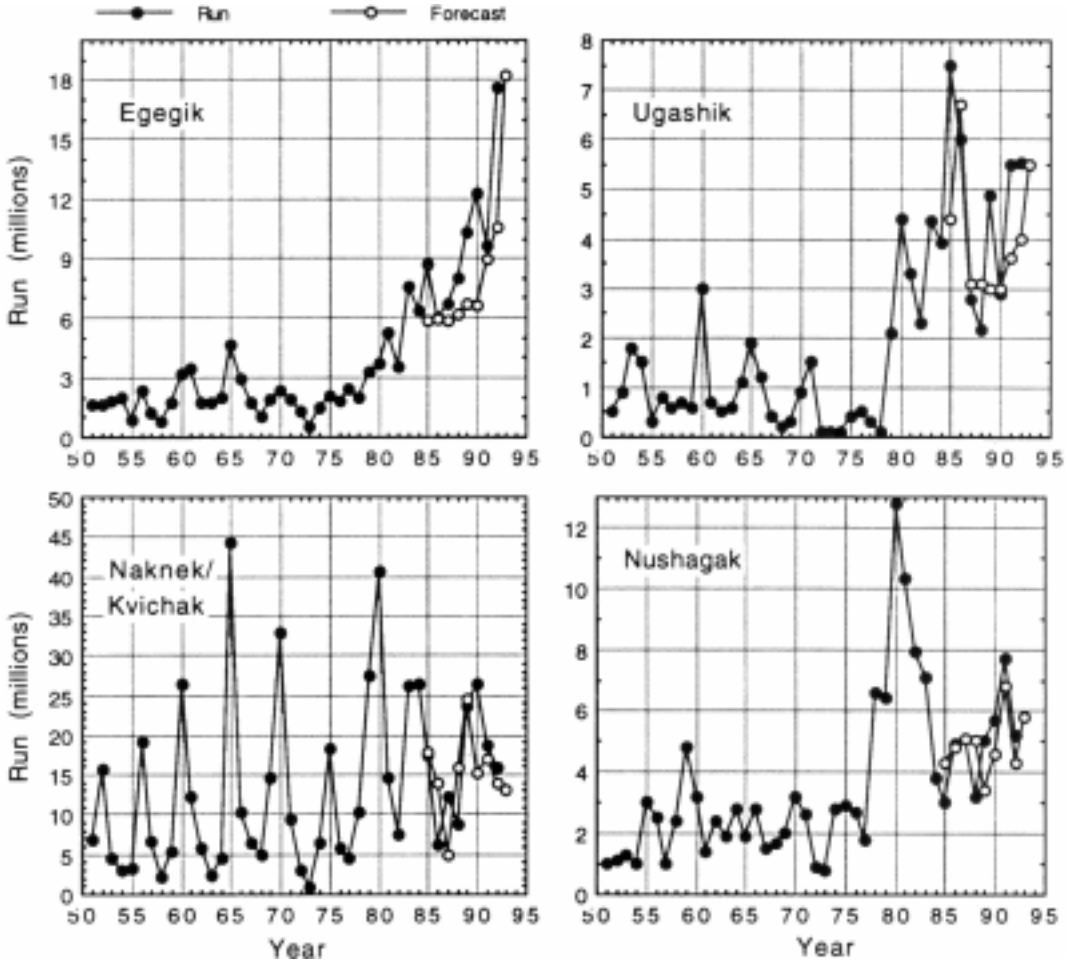

FIGURE 10. Sockeye salmon runs to the four major Bristol Bay fishing districts, 1951–92, and the FRI pre-season forecasts, 1985–93.

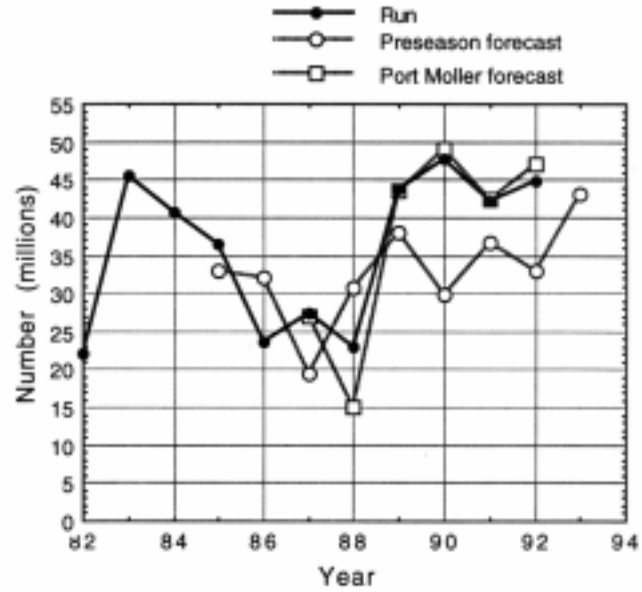

FIGURE 11. The annual Bristol Bay sockeye runs, 1982–92, the FRI pre-season forecasts, 1985–93 and the averages of the June 25 and June 30 in-season Port Moller forecasts, 1987–92.

Table 1. Forecasts and actual sockeye runs to Bristol Bay in 1992 (in millions).

	Forecasts				Actual	
	ADF&G		F.R.I.			
District	Run	Catch	Run	Catch	Run	Catch
Naknek/Kvichak						
Kvichak	12.2		10.2		10.4	
Naknek	4.2		3.2		5.0	
Branch	0.5		0.4		0.5	
Subtotal	16.9	9.7	13.8	7.2	15.9	9.4
Egegik	10.7	9.7	10.4	9.0	17.6	15.7
Ugashik	4.3	3.6	4.0	3.0	5.5	3.4
Nushagak						
Wood	2.5		2.2		2.5	
Igushik	0.7		1.0		0.8	
Nush/Nuyakuk	1.4		1.1		1.9	
Subtotal	4.6	2.9	4.3	2.5	5.2	2.9
Togiak	0.6	0.4	0.5	0.3	0.8	0.6
Bristol Bay	37.1	26.3	33.0	22.0	45.0	32.0

Table 2. Comparisons of 1992 forecasts and actual Bristol Bay sockeye runs, in millions.

District	Source	Age 1.2	2.2	0.3	1.3	2.3	Total
Naknek/Kvichak							
Kvichak	ADF&G	3.2	6.4		2.2	0.4	12.2
	FRI	2.7	5.6		1.5	0.4	10.2
	Actual	**2.4**	**4.2**		**2.4**	**1.2**	**10.4**
Naknek	ADF&G	0.6	0.8		1.5	1.3	4.2
	FRI	0.4	0.7		0.9	1.2	3.2
	Actual	**0.3**	**0.5**		**1.2**	**2.6**	**5.0**
Branch	ADF&G	0.3	+		0.2	+	0.5
	FRI	0.2	0.1		0.1	+	0.4
	Actual	**0.1**	**0.2**		**0.2**	**+**	**0.5**
Egegik	ADF&G	0.9	5.6		2.0	2.2	10.7
	FRI	0.7	5.3		2.0	2.4	10.4
	Actual	**0.4**	**8.4**		**4.3**	**4.2**	**17.6**
Ugashik	ADF&G	1.0	1.6		1.0	0.7	4.3
	FRI	0.8	1.1		1.6	0.5	4.0
	Actual	**0.4**	**1.8**		**1.6**	**1.6**	**5.5**
Nushagak							
Wood River	ADF&G	0.9	0.1		1.4	0.1	2.5
	FRI	0.7	+		1.4	+	2.2
	Actual	**1.6**	**0.1**		**0.7**	**0.1**	**2.5**
Igushik	ADF&G	0.1	+		0.5	0.1	0.7
	FRI	0.2	+		0.7	+	1.0
	Actual	**0.2**	**+**		**0.6**	**+**	**0.8**
Nush/Nuyakuk	ADF&G	0.1	+	0.7	0.6	+	1.4
	FRI	0.2	+	0.5	0.4	+	1.1
	Actual	**0.2**	**+**	**0.5**	**0.5**	**0.1**	**1.8**
Togiak	ADF&G	0.1	+		0.4	0.1	0.6
	FRI	0.1	+		0.4	+	0.5
	Actual	**0.1**	**+**		**0.5**	**0.1**	**0.8**
Bristol Bay total	ADF&G	7.2	14.5	0.7	9.8	4.9	37.1
	FRI	6.0	12.9	0.5	9.0	4.6	33.0
	Actual	**5.8**	**15.3**	**0.6**	**12.0**	**10.0**	**45.0**

[+]Less than 100,000.

Also in actual run were 1.1 million 4-ocean fish and .1 million 1-ocean fish that were not forecast but included in totals.

Table 3. Comparison of pre-season (ADFG) and in-season (Port Moller) forecasts of Bristol Bay runs (in millions).

	ADF&G Pre-season forecasts		In-season run forecasts from Port Moller test fishery issued on:				Bristol Bay final	
Year	Run	Catch	6/25	6/30	7/3-5	(catch)	Run	Catch
1987	16	9	27	27	26	15	27	16
1988	26	17	15	15	22	12	23	14
1989	29	16	50	37	42	28	44	29
1990	25	15	42	56	39	25	48	33
1991	30	21	48	37	37	21	42	26
1992	37	26	49	45	41	29	45	32

Table 4. 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. The Port Moller forecast is on 6/30 and the age composition is through 6/30 only. In 1989, the percentage of 2-ocean fish increased with date, whereas in 1990 the percentage of 2-ocean fish at Port Moller decreased with date.

		Age composition (%)						Forecast run
Year		1.2	2.2	1.3	2.3	all .2	all .3	(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	47.6
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	42.2
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

Table 5. Timing of Nushagak and Naknek/Kvichak sockeye catches, 1958-1992.

	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
Average (1981-92)	3.7	3	14	44	74	10.2	3	16	46	70

[+]Less than 1%.

Table 6. Timing of Egegik and Ugashik sockeye catches, 1958-1992.

	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
Average (1981-92)	7.1	7	25	51	79	3.0	2	6	19	49

Table 7. Fishing time in major Bristol Bay fishing districts; percent of the time (120 hr) open to fishing by 5-day periods. Bold numbers when entire district was not open (e.g., Naknek only or Igushik only). Strikes in 1982 and 1991 negated early fishing time, i.e., prior to July 4. Averages exclude 1982 and 1991.

	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
Ave.	36	21	51	63	81	80	50	17.1	29	32	36	58	73	85	50	8.5

	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
Ave.	11	23	35	62	97	90	54	5.7	36	20	32	42	57	77	59	4.3

Table 8. Average weights of sockeye (lbs) in the Bristol Bay commercial catches, 1960-1992.

	2-ocean			3-ocean			All	All	All	BB catch	Percent	Percent
Year	Male	Female	Combined	Male	Female	Combined	males	female	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
Averages												
60-76	5.4	4.7	5.1	7.5	6.4	6.8	6.2	5.5	5.8	8	41	50
77-92	5.4	4.7	5.0	7.5	6.3	6.8	6.3	5.5	5.9	22	47	51

Table 9. Forecasts of the 1993 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		2.8	4.1	6.9		0.9	1.3	2.2	9.1		
Naknek		0.4	1.0	1.4		0.9	1.3	2.2	3.6		
Branch		0.3	+	0.3		0.1	+	0.1	0.4		
	Naknek/Kvichak	3.5	5.1	8.6		1.9	2.6	4.5	13.1		6.9
	Egegik	0.4	11.0	11.4		1.1	5.7	6.8	18.2		16.2
	Ugashik	1.5	1.5	3.0		1.6	0.9	2.5	5.5		4.5
Wood		0.9	+	0.9		1.8	0.1	1.9	2.8		
Igushik		0.2	+	0.2		1.4	+	1.4	1.6		
Nush/Nuy		0.2	+	0.2	0.6	0.6	+	1.2	1.6	*	
	Nushagak	1.3	+	1.3		3.8	0.1	4.5	6.0		4.0
	Togiak	0.1	+	0.1		0.4	+	0.4	0.5		0.3
	Bristol Bay	6.8	17.6	24.4	0.6	8.8	9.3	17.7	43.3		31.9

[+]Indicates <100,000 predicted.

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

Table 10. Bristol Bay sockeye runs (millions) by age group, 1958-1992 and forecasts for 1993.

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		**6.8**	**17.6**	**24.4**	**8.8**	**9.3**	**17.7**		**43.1**	**32**
Means										
1958-77		3.9	7.9	11.9	2.5	1.9	4.5		16.4	7
1978-92		8.6	13.5	22.2	10.0	4.3	14.5	0.3	37.0	23.3

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

Smolt year	Age 1 smolt millions	Adult return (millions) 1.1	1.2	1.3	Total	Mean length age 1.2	Smlt-Ad survival (%)	Parent escape. millions	Fry length (mm)	Smolt weight (gm)	Water temp. at peak smolts	Water temp. June 1-15
81	220	.057	17.6	2.1	19.7	510	9.0	11.2	52	5.4	8.5	9.2
80	182	.000	1.7	1.1	2.8	514	1.5	4.1	62	5.9	5.3	7.3
82	150	.002	2.8	1.5	4.3	478	2.9	17.5	61	5.1	4.4	6.4
89	147	.003	4.0	2.4	6.4	493	4.4	6.1	63	5.5	5.5	6.4
76	108	.009	6.1	1.9	8.1	501	7.5	4.4	54	5.8	5.3	4.3
91	87	.002	2.8					8.3	55	5.5	5.0	6.3
86	83	.000	2.5	1.9	4.3	512	5.2	10.5	46	5.5	7.2	7.7
77	78	.005	5.5	1.2	6.7	517	8.6	13.1	49	5.5	6.4	7.6
84	52	.000	0.4	0.5	1.0	528	1.8	1.1	66	6.8	7.2	9.2
90	47	.004	2.4	0.9		495		4.1	58	5.8	6.0	8.6
78	32	.005	5.0	0.8	5.8	500	18.1	2.0	50	6.0	6.7	9.5
79	29	.039	1.8	0.8	2.7	518	9.2	1.3	58	6.0	8.0	9.2
85	24	.001	8.4	3.0	11.4	515	47.4	3.6	64	5.3	7.2	3.9
88	13	.000	0.7	1.1	1.7	490	13.2	1.2	60	5.6	6.7	7.7
87	11	.007	1.0	1.2	2.2	505	20.4	7.2	54	4.5	6.2	7.5
83	7	.000	0.8	0.2	1.0	523	14.1	1.8	51	4.9	7.3	9.3

1) 93 forecast of age 1.2 from return of age 1.1 (.002) and regression of 1.2 on 1.1 returns
   R^2= .46; F1,13= 11.00 Y= 2.46 + 180.5 (1.1 Ret)
2) 93 forecast of age 1.3 from return of age 1.2 (2.43) and mean Kvichak River temperature 6/1-15 (8.6)
   R^2= .79; F2,11= 20.51 Y= 3.24 + .087(1.2 Ret) - 4.06 (temp. 1-15)

Smolt year	Age 2 smolt millions	Adult return (millions) 2.1	2.2	2.3	Total	Mean length age 2.2	Smlt-Ad survival (%)	Parent escape. millions	Fry length (mm)	Smolt weight (gm)	Water temp. at peak smolts	Water temp. June 1-15
87	330	.043	16.4	2.4	18.7	513	5.7	10.5	46	7.0	6.2	7.5
78	213	.298	28.2	0.6	29.0	508	13.6	13.1	49	7.8	6.7	9.5
77	114	.301	16.4	0.7	17.4	532	15.3	4.4	54	10.1	6.4	7.6
82	89	.073	17.0	3.3	20.4	504	22.9	11.2	52	9.1	4.4	6.4
88	87	.028	13.1	1.5	14.6	497	16.8	7.2	54	8.3	6.7	7.7
83	76	.020	7.8	0.4	8.2	523	10.8	17.5	61	8.5	7.3	9.3
86	53	.003	1.1	0.5	1.7	533	3.2	3.6	64	10.4	7.2	7.7
90	41	.030	4.2	1.3		514		6.1	63	10.5	6.0	8.6
84	38	.000	0.9	0.2	1.1	536	2.8	1.8	51	10.0	7.2	9.2
91	34	.019	4.1					4.1	58	9.9	5.0	6.3
81	32	.016	1.2	0.8	2.0	524	6.4	4.2	62	10.2	8.5	9.2
79	26	.043	3.9	0.2	4.1	532	15.7	2.0	50	10.3	8.5	9.2
80	10	.002	0.2	0.1	0.3	531	2.7	1.3	58	10.7	5.3	7.3
89	7	.000	1.3	1.2	2.5	506	36.3	1.2	60	10.0	5.5	6.4
76	3	.002	0.3	0.5	0.8	515	26.0	0.2	65	14.2	5.3	4.3
85	2	.001	0.5	0.1	0.6	521	32.0	1.1	66	9.2	4.5	3.9

1) 93 forecast of age 2.2 from return of 2.1 (.019) and mean weight of smolts (9.9)
   R^2= .90: F2,11= 48.63 Y= 43.20 + 56(2.1 Ret) - 4.06(smolt wt)
2) 93 forecast of age 2.3 from mean length of age 2.2 (514) and regression of return of 2.3 on mean length of 2.2
   R^2= .45; F1,11= 9.15 Y= 27 - .05(mean length)

Table 12. Sockeye returns to the Naknek by number of age 1.2 for age 1. and age 2.1 for age 2.

Brood year	Escape-ment (millions)	Adult return (millions) 1.1	1.2	1.3	Total	Percent age .2 in escape.	Percent age 1.2 in return	Mean length age 1.2	Percent age 1. in return	B.B air temp. Apr/Oct
79	.92	.004	2.34	.90	3.24	65	72	475	74	7.3
86	1.98	.003	1.90	6.95	9.20	21	21	451	68	7.5
76	1.32	.004	1.03	3.74	4.77	71	22	480	63	6.9
81	1.80	.004	.76	2.48	3.24	29	23	475	63	5.8
80	2.64	.001	.68	1.37	2.05	55	33	464	51	7.8
85	1.85	.002	.64	3.41	4.05	58	16	471	60	6.7
77	1.09	.009	.60	2.04	2.64	43	23	490	84	7.7
84	1.24	.001	.46	.88	1.34	65	34	480	31	5.0
75	2.03	.001	.45	1.67	2.12	62	21	474	43	6.5
87	1.06	.000	.32	1.18	1.50	20	21	461		6.9
78	.81	.001	.30	1.60	1.90	47	16	479	55	8.9
88	1.04	.000	.27	.90		48		448		8.3
74	1.24	.002	.23	.19	.42	70	55	480	19	6.2
82	1.16	.003	.18	.75	.93	13	19	477	58	7.6
83	.89	.000	.14	.48	.62	65	23	475	44	6.8
89	1.16	.001	.40			68				7.8

1979 brood year excluded.

1) 93 forecast of age 1.2 from escapement (1.16) and regression of run on escape.
   R^2=.26; F1,12= 4.31 y= .44(Esc.) - .07
2) 93 forecast of age 1.3 from return of 1.2 (.27) and regression of 1.3 on 1.2 returns
   R^2= .91; F1,11= 106.7 y= 3.68 (1.2 Ret) - .12

Brood year	Escape-ment (millions)	Adult return (millions) 2.1	2.2	2.3	Total	Percent age.2 in escape.	Percent age2.1 in return	Percent age2.2 in return	Mean length age 2.2	Kvichak water temp. 6/1-15
84	1.24	.022	1.17	1.76	2.95	65	.75	40	491	7.5
85	1.85	.019	1.26	1.40	2.68	58	.71	47	472	7.7
80	2.64	.013	1.15	.77	1.93	55	.67	59	490	9.3
88	1.04	.013	1.00			48				6.3
75	2.03	.012	1.30	1.50	2.81	62	.43	46	490	9.5
81	1.80	.008	.46	1.46	1.93	29	.41	24	502	9.2
83	.89	.007	.32	.45	.78	65	.90	41	506	7.7
86	1.98	.006	1.23	2.61	3.85	21	.16	32	475	6.4
79	.92	.004	.76	.38	1.14	65	.35	66	471	6.4
87	1.06	.004	.53	1.30		20			476	8.6
76	1.32	.003	1.47	1.31	2.78	71	.11	53	506	9.2
74	1.24	.003	1.06	.74	1.80	70	.17	59	494	7.6
78	.81	.002	1.06	.49	1.55	47	.13	68	502	9.2
77	1.09	.000	.08	.36	.44	43	.00	18	514	7.3
82	1.16	.000	.21	.45	.66	13	.00	32	487	3.9

1) 93 forecast of age 2.2 from return of 2.1 (.013) and regression of 2.2 on 2.1 returns
   R^2= .28; F1,11= 4.33 Y= .56 + 36.38 (2.1 Ret)
2) 93 forecast of 2.3 from return of 2.2 (.53) and percent ocean age 2 (20) in escapement
   R^2 = .68; F2,9 = 9.57 Y= 1.05 + 1.29(2.2 Ret) - .021 (% age.2 Esc)

Table 13. Egegik sockeye salmon statistics ordered by number of smolt.

Smolt Year	Escapement number millions	Escapement percent age .2	Age 1 smolt number millions	Age 1 smolt weight gm	Adult return (millions) 1.1	1.2	1.3	Total	Sm-Ad survival percent	Return percent age 1.2	Mean length age 1.2
89	1.27	54	72	8.9	.000	0.86	4.34	5.20	7.2	17	496
85	0.79	88	55	10.4	.002	1.72	2.69	4.41	8.0	39	509
82	1.06	85	49	9.2	.001	0.78	2.04	2.82	5.8	28	490
88	1.15	74	36	10.2	.002	1.76	3.59	5.35	14.9	33	483
84	1.03	88	17	10.1	.002	1.01	1.79	2.80	16.5	36	510
86	1.17	69	14	9.0	.001	0.58	0.93	1.51	10.8	38	502
91	1.61	58	5	10.3	.000	0.40					
90	1.61	57	4	9.6	.001	0.40	1.10				472
87	1.10	67	4	11.6	.000	0.54	1.33	1.87	46.8	29	511
83	0.69	71	2	9.5	.000	.52	.95	1.47	73.5	35	519

1) 93 forecast of age 1.2 from return of age1.1 (0) and number of age 1 smolt (5)
R^2= .76 Y= .33 + 333(1.1 Ret) + .007(no. smolt)
2) 93 forecast of age 1.3 from return of age 1.2 (.40) and regression of 1.3 on 1.2 returns
R^2= .72 Y= .934 + .041(No. smolt)

Smolt Year	Escapement number millions	Escapement percent age .2	Age 2 smolt number millions	Age 2 smolt weight gm	Adult Return (millions) 2.1	2.2	2.3	Total	Sm-Ad survival percent	Return percent age 2.2	Mean length age 2.2
91	1.61	58	89	15.6	.063	11.00					
90	1.27	54	52	14.5	.064	8.41	5.70				492
87	1.17	69	46	14.1	.083	6.17	4.74	10.91	23.7	57	524
84	0.70	71	32	12.2	.060	3.30	1.39	4.69	14.7	70	528
86	0.79	88	30	15.7	.007	3.03	2.61	5.64	18.8	54	520
89	1.15	74	27	15.4	.010	3.79	4.21	8.00	29.6	47	502
83	1.06	85	17	13.7	.026	4.34	0.88	5.22	30.7	83	515
82	1.03	75	14	17.1	.009	2.98	1.53	4.51	32.2	66	512
88	1.10	67	13	14.3	.031	4.17	1.22	5.39	41.5	77	498
85	1.03	29	11	16.8	.012	1.74	1.59	3.33	30.3	52	529

1) 93 forecast of age 2.2 from number of smolt (89) and regression of smolt on return of 2.2
R^2= .65 Y= 1.30 + .1085(No. smolt)
2) 93 forecast of age 2.3 from escapement (1.27),number of smolt (52), return of age 2.2 (8.41) and mean length of age 2.2 (492)
R^2= .99 Y= 13.74 + 6.96(Escape) + .180(smolt)- .952(2.2 Ret)- .037(ML 2.2)

Table 14. Ugashik sockeye salmon statistics ordered by number of smolt.

Smolt Year	Escapement number millions	Escapement percent age .2	Age 1 smolt number millions	Age 1 smolt weight gm	Adult return (millions) 1.1	1.2	1.3	Total	Sm-Ad survival %	Return age 1.2 %	Mean length age 1.2
88	1.00	41	183	5.7	.001	0.48	2.38	2.86	1.6	17	488
89	0.67	56	89	6.5	.001	0.81	1.55	2.36	2.7	34	502
84	1.16	22	75	6.8	.001	0.41	0.69	1.10	1.5	37	514
86	1.24	80	38	5.8	.000	0.45	0.55	1.00	2.6	45	512
83	1.33	42	31	7.6	.002	1.51	2.51	4.02	13.0	38	514
91	1.68	84	26	7.7	.007	1.50					
90	0.64	58	15	6.7	.002	0.45	1.60				498
85	1.00	90	13	8.3	.000	0.60	0.34	0.94	7.2	64	512
87	1.00	75	6	7.9	.000	0.49	0.69	1.18	19.7	42	507

1) 93 forecast of age 1.2 from return of age 1.1 (.007) and regression of 1.2 on 1.1 returns
R^2= .59 (n=14) Y= .68 + 113.8(1.1 Ret)
2) 93 forecast of age 1.3 from mean length of age1. 2 (472) and regression of 1.3 return on length
R^2= .25 (n=13) Y= m14.56 - .026 (ML 1.2)

Smolt Year	Escapement number millions	Escapement percent age.2	Age 2 smolt number millions	Age 2 smolt weight gm	Adult return (millions) 2.1	2.2	2.3	Total	Sm-Ad Survival %	Return age 2.2 %	Mean length age 2.2
83	1.33	42	83	13.3	.004	2.20	.90	3.10	3.7		524
91	0.64	58	48	11.6	.026	1.50					
90	0.67	56	39	11.8	.010	1.78	.90	2.68	6.9	66	499
89	1.00	41	35	10.7	.001	1.83	1.63	3.46	9.9	53	506
88	1.00	75	33	10.8	.002	.95	.46	1.41	4.3	67	504
87	1.24	80	21	11.1	.054	3.50	.69	4.19	20.0	84	523
85	1.16	22	21	11.8	.001	.58	.72	1.30	6.2	45	517
86	1.00	90	15	10.9	.006	.59	.30	.89	5.9	66	528
83	3.32	85	13	13.3	.039	3.19	0.78	3.97	30.5	80	520

1) 93 forecast of age 2.2 from number of smolt (48) and return of age 2.1 (.026)
R^2= .88 (n=8) Y= .31 + .022(no.smolt) + 55.66 (2.1 Ret)
2) 93 forecast of age 2.3 from mean length of age 2.2 (499) and regression of return on length
R^2= .21 (n=12) Y= 7.6 - .0134(mean length)

Table 15. Sockeye returns to Egegik and Ugashik ordered by numbers of age 1.2 for age 1. and 2.1 for age 2.

Egegik 1973-1989 brood years

Smolt year	Age 1 mean weight	Adult return (millions) 1.1	1.2	1.3	Total	% 1.2	Mean length 1.2	Smolt year	Age 2 mean weight	Adult return (millions) 2.1	2.2	2.3	Total	% 2.1	% 2.2	Mean length 2.2
88	10.2	.002	1.76	3.59	5.35	33	483	87	14.1	.083	6.17	4.74	10.99	.76	56	524
85	10.4	.003	1.72	2.69	4.41	39	509	90	14.5	.064	8.41	5.70	14.17			492
84	10.1	.002	1.01	1.79	2.80	36	510	91	15.6	.063	11.00					
89	8.9	.000	.86	4.34	5.20	17	496	84	12.2	.060	3.30	1.39	4.75	1.26	69	528
82	9.2	.001	.78	2.04	2.82	28	490	79		.059	2.81	0.74	3.61	1.63	78	528
79		.002	.77	1.76	2.53	30	529	88	14.3	.031	4.17	1.22	5.42	.57	77	498
81	9.1	.003	.68	0.51	1.19	57	519	83	13.7	.026	4.34	0.88	5.25	.50	83	515
86	9.0	.001	.58	0.93	1.51	38	502	77	13.2	.018	2.17	0.47	2.66	.68	82	532
78	10.1	.000	.58	0.73	1.31	44	503	85	16.8	.012	1.74	1.59	3.34	.36	52	529
87	11.6	.000	.54	1.33	1.87	29	511	89	15.4	.010	3.79	4.21	8.01	.12	47	502
83	9.5	.000	.52	0.95	1.47	35	519	82	17.1	.009	2.98	1.53	4.52	.20	66	512
90	9.6	.001	.40	1.10			472	78	15.6	.009	2.28	0.73	3.02	.30	76	512
91	10.3	.000	.40					86	15.7	.007	3.03	2.61	5.65	.12	54	520
80		.000	.36	.48	.84	43	514	81	14.6	.006	5.72	2.02	7.75	.08	74	534
77	11.3	.000	.14	.23	.37	38	522	80		.001	0.59	0.59	1.18	.08	50	521
76		.000	.13	.10	.23	57	518	76		.000	0.56	0.82	1.38	.00	41	526
75		.000	.07	.12	.19	37	522									

Ugashik 1973-1989 brood years

Smolt year	Age 1 mean weight	Adult Return (millions) 1.1	1.2	1.3	Total	% 1.2	Mean length 1.2	Smolt year	Age 2 mean weight	Adult Return (millions) 2.1	2.2	2.3	Total	% 2.1	% 2.2	Mean length 2.2
81		.020	2.95	0.81	3.78	78	528	79		.058	1.17	0.38	1.61	3.61	73	545
91	7.7	.007	1.50					87	11.1	.054	3.50	0.69	4.24	1.27	82	523
78		.000	1.92	1.41	3.33	58	510	83	13.3	.039	3.19	0.78	4.01	.97	80	520
83	7.6	.002	1.51	2.51	4.02	38	514	91	11.6	.026	1.50					
77		.002	1.43	0.55	1.98	72	532	90	11.8	.010	1.78	0.90				499
82	6.3	.001	1.14	2.10	3.24	35	496	77		.010	0.60	0.08	.69	1.45	87	537
89	6.5	.001	0.81	1.55	2.36	34	502	82		.008	1.39	0.52	1.92	.42	72	502
85	8.3	.000	0.60	0.34	0.94	64	512	81		.007	0.81	0.50	1.32	.53	62	534
79		.002	0.55	1.43	1.98	28	540	86	10.9	.006	0.59	0.30	.90	.67	66	528
87	7.9	.001	0.49	0.69	1.18	41	507	84	10.3	.004	2.20	0.90	3.10	.13	71	524
88	5.7	.001	0.48	2.39	2.87	17	488	88	10.8	.002	0.95	0.46	1.41	.14	67	504
90	6.7	.002	0.45	1.60			498	89	10.7	.001	1.83	1.63	3.46	.03	53	506
86	5.8	.000	0.45	0.55	1.00	45	512	85	11.8	.001	.58	.72	1.30	.08	45	517
84	6.8	.001	.41	.69	1.10	37	514	80		.000	.23	.17	.40	.00	58	537
80		.000	.22	.39	.61	36	529	76		.000	.01	.04	.05	.00	20	533
75	6.4	.000	.01	.01	.02	50	532									
76		.000	.01	.01	.02	50	510									

Table 16. Sockeye salmon statistics used to forecast Wood River and Igushik runs.

Wood River

Brood year	Escapement Number millions	Distri-bution	Percent age .2	Mean length Fry on9/1	Age 1 smolt	Adult return (millions) 1.2	2.2	1.3	2.3	Total	Mean length of 1.2
74	1.71	3	86	52	82	2.85	0.41	1.57	0.05	4.88	499
75	1.27	6	41	49	69	1.54	0.38	1.86	0.64	4.42	512
76	0.82	4	62	52	78	2.17	0.51	2.18	0.25	5.11	492
77	0.56	2	27	62	88	0.92	0.07	2.08	0.03	3.10	510
78	2.27	4	79	54	77	1.18	0.80	1.10	0.11	3.19	482
79	1.71	1	53	49	84	2.46	0.03	1.56	0.02	4.07	504
80	2.97	18	59	55	78	0.46	0.10	0.95	0.10	1.61	493
81	1.23	8	37	53	85	0.60	0.08	1.14	0.09	1.91	490
82	0.98	12	34	61	90	0.50	0.13	0.90	0.02	1.55	501
83	1.36	4	75	63	90	1.91	0.02	1.23	0.07	3.23	495
84	1.00	8	22	55	86	0.52	0.03	1.32	0.02	1.89	502
85	0.94	14	49	55	86	1.11	0.03	1.37	0.01	2.52	501
86	0.82	9	36	55	82	1.16	0.07	1.94	0.06	3.23	480
87	1.34	1	82	57	85	1.36	0.09	0.74	0.08	2.27	486
88	0.87	3	37	56	91	1.59	0.01	1.83			482
89	1.19	12	49	58		.89					

1) 93 forecast of age 1.2 from percent age .2 in escapement(49) and distribution of escapement (12)
R^2= .57; F2,12= 7.84 Y= 1.07 + .015(%2 Esc.) = .076(Esc. distr.)
2) 93 forecast of age 2.2 from mean length of age 1 smolt (91) and regression of 2.2 on smolt length
R^2= .41; F1,12= 8.19 Y= 2.36 - .026(smolt length)
3) 93 forecast of age 1.3 from age 1.2 return (1.59) and percent age .2 in escapement (37)
R^2= .60; F2,11= 8.28 Y= 1.65 + .535(1.2 Ret) - .018(%age .2)
4) 93 forecast of age 2.3 from return of age 2.2 (.09) and regression of 2.3 on 2.2 returns
R^2= .17; F1,11= 2.29 Y= .05 + .29(2.2 Ret)

Igushik

Brood Year	Escapement Number	% age.2	Air temp. for: Fry	Smolt	Adult returns (millions) 1.2	2.2	1.3	2.3	Total	Length of 1.2
74.00	0.36	71.00	6.20	1.10	0.34	0.36	0.74	0.02	1.46	516
75.00	0.24	27.00	6.50	0.50	0.82	0.13	2.39	0.49	3.83	525
76.00	0.19	44.00	6.90	3.90	0.52	0.21	1.41	0.17	2.31	512
77.00	0.10	20.00	7.70	4.40	0.32	0.01	1.56	0.00	1.89	531
78.00	0.54	50.00	8.90	3.80	0.05	0.06	0.27	0.01	0.39	515
79.00	0.86	58.00	7.30	5.50	0.32	0.02	0.38	0.01	0.73	521
80.00	1.99	22.00	7.80	0.00	0.01	0.04	0.21	0.06	0.32	531
81.00	0.59	24.00	5.80	4.70	0.15	0.00	0.83	0.05	1.03	512
82.00	0.42	5.00	7.60	1.80	0.05	0.01	0.48	0.01	0.55	548
83.00	0.18	73.00	6.80	-0.50	0.15	0.01	0.33	0.03	0.52	508
84.00	0.19	9.00	5.00	1.40	0.03	0.05	0.63	0.03	0.74	525
85.00	0.21	37.00	6.70	2.40	0.51	0.08	0.90	0.08	1.57	525
86.00	0.31	7.00	7.50	2.10	0.23	0.03	2.20	0.03	2.49	494
87.00	0.17	40.00	6.90	3.40	0.16	0.01	0.57	0.03	0.77	516
88.00	0.17	12.00	8.30	5.00	0.19	0.02	1.37			503
89.00	0.46	49.00	7.80	3.80	0.18					

1) 93 return of age 1.2 from recent 10-year average
2) 93 return of age 2.2 from return of 1.2 (.19) and regression of 2.2 on 1.2 return
R^2=.21; F1,12= 3.10 Y= .021 + .197 (1.2 Ret)
3) 93 return of age 1.3 from age 1.2 return (.19), percent age 2 in escape. (12) and length of 1.2 (503)
R^2= .89; F3,10= 26.55 Y= 13.23 + 2.36(1.2 Ret) - .02(%.2 Esc) - .024(Length 1.2)
4) 93 return of Aage 2.3 from recent 10-year average

Table 17. Sockeye salmon statistics used to forecast Nushagak and Togiak runs.

Nushagak/Nuyakuk

Brood year	Escapement Number millions	Escapement Age .2 percent	Bristol Bay Apr-Oct air temp. for fry	Adult Return (millions) 0.2	0.3	0.4	1.2	1.3	1.4	Total	Mean length age 1.2
78	0.66	11	8.9	0.02	0.42	0.14	0.09	0.74	0.00	1.41	487
79	0.50	53	7.3	0.02	0.45	0.02	0.47	0.81	0.04	1.81	499
80	3.32	10	7.8	0.02	0.43	0.07	0.08	0.32	0.00	0.92	497
81	1.01	13	5.8	0.01	0.12	0.01	0.16	1.43	0.06	1.79	487
82	0.60	7	7.6	0.04	0.33	0.05	0.16	0.85	0.06	1.49	497
83	0.40	35	6.8	0.10	0.57	0.12	0.11	0.62	0.02	1.54	502
84	0.59	16	5.0	0.01	0.22	0.03	0.12	0.55	0.02	0.95	493
85	0.50	48	6.7	0.06	0.49	0.06	0.06	0.59	0.01	1.27	459
86	0.99	6	7.5	0.06	0.83	0.06	0.11	0.67	0.21	1.94	471
87	0.39	28	6.9	0.14	0.92	0.25	0.04	0.52	0.06	1.93	462
88	0.48	16	8.3	0.07	0.52	0.11	0.21	0.59			468
89	0.50	14	7.8	0.07	0.57		0.11				
90	0.67	22	8.0	0.08							

1) 93 forecasts for ages 0.2, 1.2,1.3 and 1.4 from recent 5-year averages
2) 93 forecast of age 0.3 from age 0.2 return (.07) and regression of 0.3 on 0.2 return
   R^2= .66; F1,9= 17.21 Y= .252 + 4.593(0.2 Ret)
3) 93 forecast of age 0.4 from return of 0.2 (.07) and regression of 0.4 on 0.2 return
   R^2=.63; F1,8= 13.85 Y= .017 + 1.332(0.2 Ret)

Togiak

Brood year	Escapement Number (millions)	Escapement Age .2 percent	Bristol Bay Apr-Oct air temp. for fry	Adult Return (millions) 0.2	0.3	1.2	1.3	2.2	2.3	Total	Mean length age 1.2
74	.10	33	6.2		.00	.26	.29	.07	.04	.66	527
75	.18	33	6.5		.01	.19	.81	.08	.05	1.14	530
76	.19	29	6.9		.00	.18	.52	.13	.15	.98	529
77	.16	58	7.7		.00	.22	.55	.01	.01	.79	537
78	.31	45	8.9		.01	.13	.41	.06	.02	.63	512
79	.20	40	7.3		.00	.26	.28	.01	.00	.55	536
80	.53	19	7.8		.00	.04	.21	.01	.02	.28	521
81	.31	30	5.8		.01	.05	.24	.01	.02	.33	501
82	.29	28	7.6		.02	.11	.24	.01	.02	.40	513
83	.21	41	6.8		.00	.28	.91	.01	.02	1.22	516
84	.15	20	5.0		.01	.02	.11	.00	.02	.16	520
85	.15	27	6.7		.01	.03	.21	.04	.08	.37	513
86	.20	39	7.5		.03	.08	.44	.08	.11	.74	504
87	.28	73	6.9		.01	.19	.53	.03	.03	.79	514
88	.31	3	8.3		.01	.11	.35	.03			515
89	.10	24	7.8			.12					

1) 93 forecast of age 1.2 from percent age 2 in escapement (24) and regression of 1.2 ret. on % age .2
   R^2= .24; F1,13= 4.17 Y= .052 + .003(% .2 Esc)
2) 93 forecast of age 1.3 from return of 1.2 (.11) and regression of age 1.3 on 1.2 returns
   R^2= .40; F1,12=8.08 Y= .175 + 1.617(1.2 Ret)
3) 93 forecast of age 2.2 from recent 5-year average
4) 93 forecast of age 2.3 from return of 2.2 (.03) and regreession of 2.3 on 2.2 return