

2017 Bristol Bay Sockeye Salmon Forecast

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The 2017 Bristol Bay sockeye salmon forecast is 43.1 million. This forecast is 4% higher than the recent 10-year average (41.4 million) and 19% higher than the recent 20-year average (36.2 million). This estimate is the sum of individual predictions for each of the predominant age classes (1.2, 1.3, 2.2, 2.3) for all nine major river systems – Kvichak, Egegik, Ugashik, Naknek, Alagnak, Wood, Nushagak-Mulchatna, Igushik, and Togiak, and the contribution of Nushagak 0.3 and 1.4 age classes (Table 1, Fig. 1). The predicted total harvest based on this forecast is 30.5 million sockeye with an estimated weight of 177.1 million pounds (Table 2). To generate the forecast for total harvest we subtracted 1) our estimate of escapement for each river; in most cases we used the number for the upper bounds of the lower half of the ADF&G escapement goal range, except in the cases of the Kvichak and Alagnak rivers where we simply used half of predicted inshore return of sockeye, and 2) an estimate of the 2016 South Peninsula harvest from the predicted total run. South Peninsula catch for 2017 is estimated as the average of the catch (South Unimak and Shumagin Islands) from 1990 to 2016. Harvest values for 2017 given in Tables 1 and 2 are “forecasted” inshore harvest, differing from what we have referred to as “potential” harvest in prior preseason forecasts only by the removal of the estimated 2017 South Peninsula catch. This harvest estimate still depends on all the escapement goals being achieved at the listed escapement values in Table 1, and industry's ability to take surplus fish. To determine the harvest in pounds for each age group we multiplied the forecasted catch by the long-term average weight of 2 or 3 ocean fish for Bristol Bay sockeye runs totaling 40 million sockeye or greater (4.8 lbs and 6.7 lbs, respectively).

Historical catch and escapement data collected by the Alaska Department of Fish and Game from 1963 to present were used to generate the 2017 forecast. Pre-season forecasts generated between 2004 and 2011 used a shorter time series of this data (1978-2011) to make predictions because 1978 is commonly recognized as a point when long-term trends in productivity of the North Pacific and Bristol Bay sockeye stocks showed a dramatic increase. However, large-scale shifts in climate patterns have become more variable since 2000. We now use the 1963 to present and the 1980 to present sockeye return data sets selectively for each individual prediction, based upon retrospective analysis of how well forecast models have performed in recent years using each data set. All but ten of the 2017 forecasts (38 individual predictions) are based on prior returns of “siblings” or younger ocean age-classes from the same brood year. In ten instances (Alagnak, Egegik, Wood, Nushagak, Igushik - 1.2s, Kvichak, Alagnak, Wood, Togiak – 1.3s, and Nushagak 1.3s) we used auto-regressive integrated moving average models (ARIMA). We chose ARIMA models in those instances because the sibling regression

models generated estimates outside historical bounds or showed very little predictive accuracy for that specific stock by age-class group. ARIMA models generate forecasts based on how well patterns in a time-series of data predict future values. These models consider the level of autocorrelation in the time series of returns for stock-age groups in addition to the moving average of the forecast errors in prior years, and are independent of the information provided by the abundance of sibling age classes. For all forecasts generated based on sibling abundance data, rather than simply choosing the best sibling relationship for each age and river, we use a technique that weights the forecasts for all potential predictor sibling models according to how well they have performed in the past. While the best sibling relationship carries the most weight in our forecasts for each stock-age group, retrospective analysis indicates that there is useful information conveyed by other models (i.e. sibling models that include alternative age classes and different combinations thereof), and that this information increases forecast accuracy. In addition, we increased reliance on forecasts generated by ensemble models. Ensemble models simply average the range of forecasts generated by all model types, under the assumption that both sibling regression and ARIMA models provide predictive information. Only twice (Egegik 1.2 and Naknek 2.3) were these selected as the best estimate for 2017.

The 2017 forecast of 43.1 million sockeye is 17.6% and 27.7% lower than the observed sockeye runs in 2016 and 2015 respectively. However, this forecast is strikingly similar to both of those observed runs and the 2015 and 2016 forecast in that the forecast total results from relatively strong predictions across most rivers (Kvichak being the exception with a more moderate forecast relative to historical observed runs) and age classes (Figure 1). 2017's total forecast does not approach 50 million because no individual prediction exceeds 3.2 million sockeye. In almost all years with a forecast exceeding 40 million sockeye the overall forecast is dominated by a single river and often a single age group (e.g. Kvichak or Egegik 2.2s). The 2017 forecast of 43.1 million is significantly above the long-term (1960-2016) average Bristol Bay run size of 32.5 million sockeye. Of this total we expect 46% 2-ocean sockeye and 54% 3-ocean sockeye. Historically, the average range for weight of 2-ocean sockeye is 4.6-5.4 lbs and 6.4-7.5 lbs for 3-ocean sockeye.

Table 1. 2017 pre-season forecast of the number of sockeye salmon in millions returning to Bristol Bay, Alaska by river system and age class.

DISTRICT	RIVER	AGES				TOTAL	ESCAPEMENT	Estimated S. PEN CATCH	Inshore HARVEST	millions of fish
		1.2	1.3	2.2	2.3					
Naknek\Kvichak		5.55	7.54	2.95	1.16	17.20	6.58	0.54	10.09	
	Kvichak	2.19	2.90	2.16	0.37	7.62	3.69	0.24	3.69	
	Naknek	2.06	2.90	0.56	0.58	6.10	1.20	0.19	4.71	
	Alagnak ^a	1.30	1.74	0.23	0.21	3.48	1.69	0.11	1.69	
Egegik		2.25	2.96	3.04	2.46	10.71	1.40	0.34	8.97	
Ugashik		1.43	2.50	0.59	0.48	5.00	0.95	0.16	3.89	
Nushagak		3.58	5.29	0.19	0.10	9.40	2.17	0.29	6.94	
	Wood	3.17	2.46	0.17	0.07	5.87	1.25	0.18	4.43	
	Nushagak ^b	0.21	1.91	0.01	0.01	2.38	0.64	0.07	1.67	
	Igushik	0.20	0.92	0.01	0.02	1.15	0.28	0.04	0.84	
Togiak		0.15	0.59	0.03	0.02	0.79	0.20	0.02	0.57	
Totals		12.96	18.88	6.80	4.22	43.10^c	11.30	1.35	30.46	

^aThe spawning goal for the Alagnak River was set by ADFG as the estimated escapement based on exploiting the return of sockeye to the Alagnak at the same rate as the return to the Kvichak

^bThe Nushagak River total forecast includes 232,000 age 0.3 and age 1.4 sockeye

^cThe 'Totals' category cannot be summed horizontally because the Nushagak 1.4's and 0.3's are not included in the 'Ages' part of the table.

Table 2. 2017 pre-season Bristol Bay sockeye forecast in millions of pounds by fishing district and age class.

DISTRICT	1.2	1.3	2.2	2.3	Inshore Harvest	
					lbs (millions)	no. of fish (millions)
NakneklKvichak	15.72	29.99	7.60	4.90	58.21	10.09
Egegik	9.05	16.62	12.23	13.79	51.69	8.97
Ugashik	5.35	13.01	2.20	2.50	23.06	3.89
Nushagak ^a	12.83	25.51	0.65	0.53	40.62	6.94
Togiak	0.53	2.83	0.10	0.10	3.56	0.57
Totals	43.48	87.96	22.78	21.82	177.14^b	30.46

^aThe Nushagak District harvest totals cannot be summed horizontally because of the inclusion of age 0.3 and age 1.4 sockeye

^bThe Harvest totals cannot be summed horizontally because of the inclusion of Nushgak river age 0.3 and age 1.4 sockeye

Table 3. 2017 and 2016 preseason forecast of the number of sockeye salmon in millions returning to Bristol Bay, Alaska by river system, and actual returns of sockeye salmon in millions by river system 2007-2016.

RIVER	2017 Forecast	2016 Forecast (last year's)	ACTUAL RETURNS									
			2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Kvichak	7.62	13.00	12.03	16.60	14.23	4.79	11.15	6.18	9.41	5.70	5.87	4.38
Naknek	6.10	4.90	5.44	4.82	5.91	2.35	3.38	5.11	5.82	4.66	6.52	9.05
Alagnak	3.48	5.52	5.16	12.45	0.89	2.49	2.60	2.52	2.64	2.57	6.16	4.43
Egegik	10.71	10.55	9.40	8.80	7.80	5.96	6.01	5.89	6.01	12.95	9.03	8.21
Ugashik	5.00	4.79	8.80	6.95	1.94	3.46	3.24	3.79	4.92	4.03	3.05	7.90
Wood	5.87	8.16	5.49	5.07	7.47	3.17	2.64	4.58	7.77	7.35	5.46	6.76
Nushagak	2.38	2.15	3.20	2.25	1.66	2.09	1.14	1.58	2.17	1.67	1.71	2.67
Igushik	1.15	1.17	1.95	1.65	0.98	0.74	0.50	1.20	1.38	0.95	3.43	1.83
Togiak	0.79	0.69	0.94	0.57	0.58	0.66	0.86	0.98	0.85	0.85	0.89	1.07
TOTALS	43.10	50.93	52.40	59.16	41.46	25.71	31.52	31.83	40.98	40.72	42.12	46.28

Figure 1. Stock-specific comparison of the 2017 preseason forecast by age class (right panel) with observed run size by age class 1970 – 2016 (left panel).



