2012 Alaska Department of Fish and Game Southeast Alaska Pink Salmon Harvest Forecast

The Southeast Alaska pink salmon harvest in 2012 is predicted to be in the *weak* range, with a point estimate of **17 million fish (80% confidence interval: 10–29 million fish).** The categorical ranges of pink salmon harvest in Southeast Alaska were formulated from the 20th, 40th, 60th, and 80th percentiles of historical harvest from 1960 to 2010:

Category	Range (millions)	Percentile
Poor	Less than 11	Less than 20th
Weak	11 to 19	20th to 40th
Average	19 to 29	40th to 60th
Strong	29 to 48	60th to 80th
Excellent	Greater than 48	Greater than 80th

Forecast Methods:

The 2012 forecast is an average of two forecasts: 1) a forecast of the trend in the harvest, and 2) the forecast trend adjusted using 2011 juvenile pink salmon abundance data. The forecast of the trend in pink salmon harvests was based on a time-series technique called *exponential smoothing.* This technique is similar to a running average, except that all harvests since 1960 were used in the forecast estimate. Recent harvest observations were given more weight in the analysis, while past harvest observations were increasingly down-weighted with time; i.e., the older the datum, the less influence it has on the forecast. If x_t, x_{t-1}, ... denotes the observed harvests in year t, t-1, and so on, then the forecast in year t+1 is given by,

$$\hat{x}_{t+1} = cx_t + (1-c)\hat{x}_t \ .$$

We estimated a value of c to be approximately 0.45, based on minimizing the sum of past squared errors in the entire data set (odd and even years combined).The forecast for year t, that is $\hat{x}_t$, is also a weighted average of the forecast made for year t-1 and the actual harvest in year t-1. This is a kind of recursive equation that contains all of the data in the series. Because the recent harvest series has developed an odd-year and even-year cycle, we let t be 2010, the parent year for the 2012 return. Since the formula used to calculate the forecast is a weighted average of the 2010 harvest and its associated forecast, which was also based on the associated parent year harvest and forecast, this forecast is based entirely on even-year data. That is, we used all of the even-year harvest data up to 2010, assuming that the 2010 parent year and other even years in the series will better predict the 2012 return. This analysis produced a forecast of 23 million pink salmon (Figure 1).

We adjusted the forecast using peak June–July juvenile pink salmon catch-per-unit-effort (CPUE) statistics provided by the NOAA Fisheries, Alaska Fisheries Science Center, Auke Bay Laboratories (Joe Orsi, Auke Bay Laboratories, personal communication). These data were obtained from systematic surveys conducted annually in upper Chatham and Icy straits in conjunction with NOAA's Southeast Coastal Monitoring Project and are highly correlated with the harvest of adult pink salmon in the following year (see Orsi et al. 2006[1]). We developed a simple equation to predict the forecast error in the

[1] We gratefully acknowledge the assistance and advice of Joe Orsi and Alex Wertheimer (retired) and their colleagues at the NOAA Auke Bay Laboratories. However, we accept responsibility for this forecast, and we accept sole responsibility for this use of their data. For a detailed description of these NOAA research activities see: Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, B. L. Wing, A. C. Wertheimer, and W. R. Heard. 2006. Annual Survey of Juvenile Salmon and Ecologically Related Species and Environmental Factors in the Marine Waters of Southeastern Alaska, May–August 2005 (NPAFC Doc. 955) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA, 108 p.; http://www.npafc.org/new/pub_documents.html.

exponential smooth by regressing the forecast error proportions from 1998 to 2011 on the corresponding NOAA CPUE data from 1997 to 2010 (Figure 2). The forecast error proportion was simply the forecast error (the exponential smooth forecast subtracted from the actual harvest) divided by the forecast point estimate. We predicted the 2012 forecast error and adjusted the exponential-smooth forecast downward, from 23 million to 10 million pink salmon (Figure 3).

Finally, we gave equal weight to both the exponential-smooth forecast (23 million) and the adjusted forecast (10 million), and present the point estimate of 17 million pink salmon as the 2012 pink salmon harvest forecast. We used this "equal-weight" approach to produce hindcast predictions for 1998–2011, and calculated the sum of the squared errors of the log of the observed values minus the log of the predicted values. The 80% confidence interval (10–29 million) was calculated as the harvest forecast plus or minus the root-mean-squared error times the appropriate *t*-value (1.350).

Forecast Discussion:

The 2012 harvest forecast of 17 million pink salmon is well below the recent 10-year average harvest of 40 million pink salmon, but is equal to the average harvest over the past three even years. There are two primary reasons to expect that the harvest in 2012 will be smaller than the recent average. First, although biological escapement goals were met in the parent year, 2010, escapement indices were below average on inside waters north of Sumner Strait. Management targets for pink salmon were not met in districts 112, 113 inside, 114, and 115, and, at a finer scale, for 7 of the 24 pink salmon stock groups in this area. In addition, the NOAA Auke Bay Lab's 2011 peak June–July juvenile pink salmon CPUE statistic from upper Chatham and Icy straits in northern Southeast Alaska ranked in the bottom third of the 14 previous years that NOAA has collected that information, which may indicate poor freshwater and early marine survival for pink salmon set to return in 2012. Pink salmon harvests associated with the bottom third of indices in the NOAA data set ranged between 12 and 20 million fish.

The NOAA Auke Bay Laboratories continues to conduct research that has greatly improved our ability to forecast pink salmon harvests in Southeast Alaska. ADF&G forecasts that were adjusted using NOAA's juvenile pink salmon data were much improved over previous forecasts (Figure 4). Hindcasts of past harvests (1998–2006) using this forecast method also exhibited fair to good performance in predicting the direction of forecast error (Figure 3). Even if these hindcast values were not always precise (e.g., in 2006), the ability to predict if the harvest will be greater than average or less than average is an immense improvement over past ADF&G forecasts. For these reasons, we are using this method to forecast the pink salmon harvest for a sixth straight year.

The department will manage the commercial purse seine fisheries *inseason* based on the strength of salmon runs. Aerial escapement surveys and fishery performance data will continue, as always, to be essential in making inseason management decisions.

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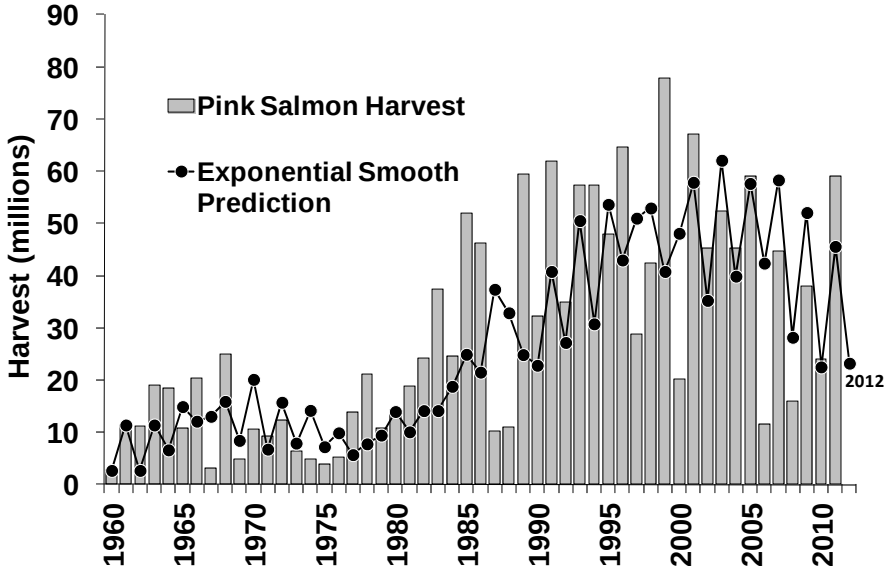

Figure 1. Comparison of the annual harvest of pink salmon in Southeast Alaska, and exponential smoothed hindcast values of the harvest used in the 2012 forecast model. This method produced a 2012 harvest forecast of 23 million pink salmon.

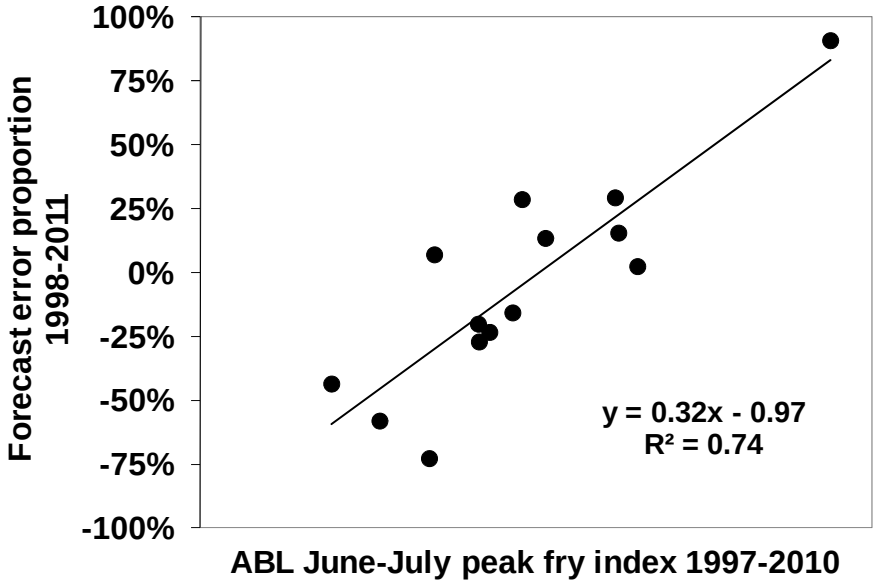

Figure 2. Regression of ADF&G forecast error proportion on the peak June–July juvenile pink salmon index from Icy Strait one year prior. (Pink salmon fry index data provided by Joe Orsi, NOAA Auke Bay Laboratory, pers. comm.). The forecast error is a proportion calculated by dividing the forecast error (the annual ADF&G forecast subtracted from the actual harvest) by the forecast point estimate.

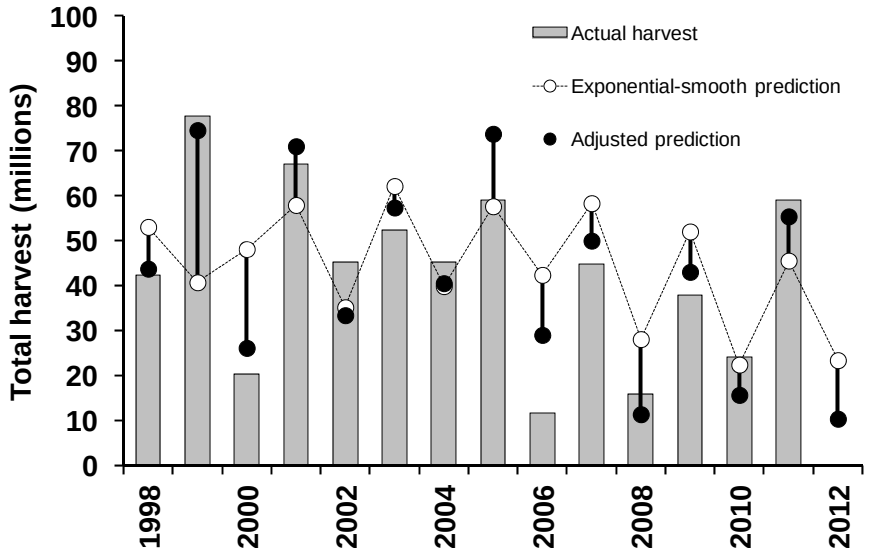

Figure 3. Annual harvest of pink salmon in Southeast Alaska, 1998–2011, compared to the exponential smoothed hindcast predictions of the harvest adjusted using NOAA Auke Bay Laboratory juvenile pink salmon data.

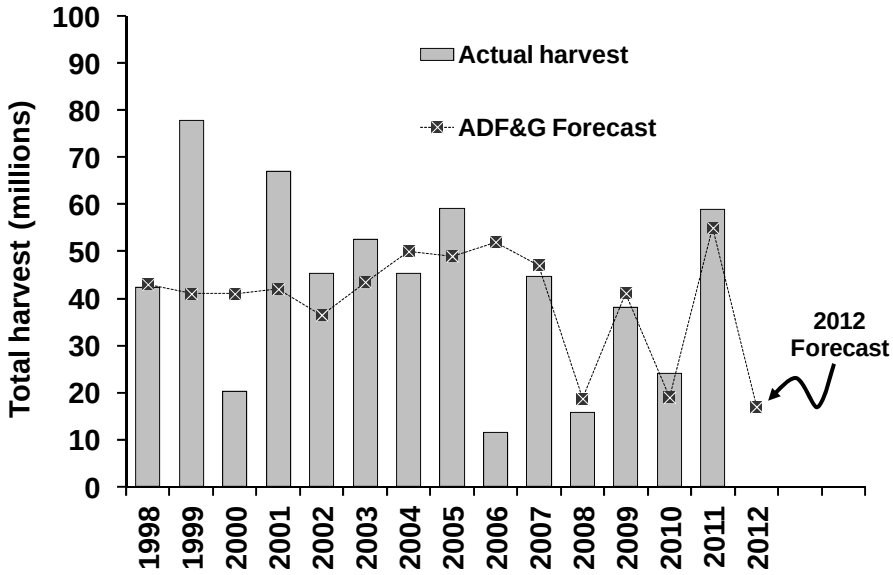

Figure 4. Annual harvest of pink salmon in Southeast Alaska compared to the ADF&G pre-season harvest forecast, 1998–2011. The 2007–2011 ADF&G harvest forecasts were adjusted using NOAA's juvenile pink salmon data.