2010 Alaska Department of Fish and Game Southeast Alaska Pink Salmon Harvest Forecast

The Southeast Alaska pink salmon harvest in 2010 is predicted to be in the *Weak* to *Average* range, with a point estimate of **19 million fish (80% confidence interval: 11–32 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 2009:

Category	Range (millions)	Percentile
Poor	Less than 11	Less than 20th
Weak	11 to 18	20th to 40th
Average	18 to 30	40th to 60th
Strong	30 to 49	60th to 80th
Excellent	Greater than 49	Greater than 80th

Forecast Methods:

The 2010 forecast is an average of two forecasts: 1) a forecast of the trend in the harvest, and 2) the forecast trend adjusted using 2009 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,

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

The forecast for year t, that is $\hat{x}_t$, is also a weighted average of the observed catch in year t-1, and the forecast in year t-2. 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 2008, the parent year for the 2010 return. Since the formula used to calculate the forecast is a weighted average of the 2008 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 2008, assuming that the 2008 parent year and other even years in the series will better predict the 2010 return. We estimated a value of c to be approximately 0.46, based on minimizing the sum of past squared errors in the entire data set (odd and even years combined). This analysis produced a forecast of 22 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 and their colleagues at the NOAA Auke Bay Lab. 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 2009 on the corresponding NOAA CPUE data from 1997 to 2008 (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 2010 forecast error and adjusted the exponential-smooth forecast downward, from 22 million to 15 million pink salmon (Figure 3).

Finally, we gave equal weight to both the exponential-smooth forecast (22 million) and the adjusted forecast (15 million), and present the point estimate of 19 million pink salmon as the 2010 pink salmon harvest forecast. We used this "equal-weight" approach to produce hindcast predictions for 1998–2009, 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 (11–32 million) was calculated as the harvest forecast plus or minus the root-mean-squared error times the appropriate *t*-value (1.363).

Forecast Discussion:

The 2010 forecast of 19 million pink salmon is 48% of the recent 10-year average harvest of 40 million pink salmon. There are two primary reasons to expect that the harvest in 2010 will be smaller than the recent average. The first is that the parent-year escapement index in 2008 was the smallest since 1990 (only 56% of the prior 10-year average). Escapements were extremely poor on the inside waters north of Sumner Strait, where pink salmon escapement indices were below the recommended management targets for 19 of 21 pink salmon stock groups. In addition, the NOAA Auke Bay Lab's 2009 peak June–July juvenile pink salmon CPUE statistic from upper Chatham and Icy straits in northern Southeast Alaska ranked in the bottom third out of the 12 previous years that NOAA has collected that information. Pink salmon harvests associated with the three previous smallest indices in their data set ranged between 12 and 20 million fish.

We point out that this year's forecast is similar to our 2008 forecast in that we gave equal weight to both the exponential-smooth forecast and the adjusted forecast, rather than simply using the adjusted forecast as we did for the 2007 and 2009 seasons (Figure 3). We feel this slightly more cautious approach is warranted, given that the exponential-smooth forecast for 2010 already accounts for the recent downward trend in even-year harvests and, while parent-year escapements were extremely poor in Northern Southeast Alaska (where the NOAA's juvenile pink salmon data are collected), 2008 pink salmon escapement indices in Southern Southeast Alaska (Sumner Strait and south) were improved over 2006.

The NOAA Auke Bay Lab 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 (1998–2009) 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 fourth 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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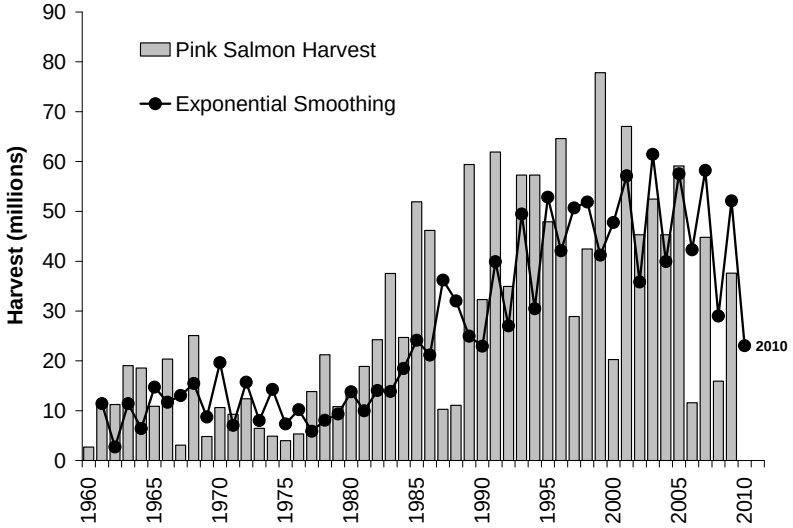

Figure 1. Comparison of the annual harvest of pink salmon in Southeast Alaska, and exponential smoothed hindcast values of the harvest used in the 2010 forecast model. This method produced a 2010 harvest forecast of 22 million pink salmon.

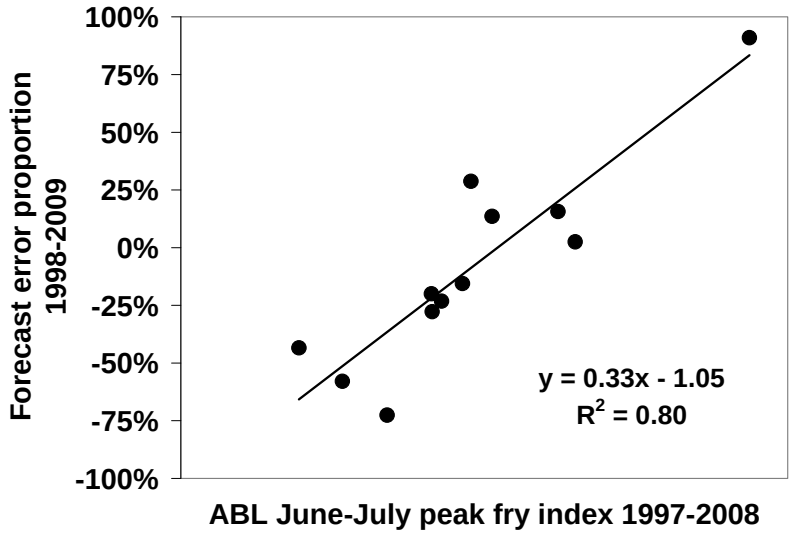

Figure 2. Regression of ADF&G forecast error proportion on the peak June–July juvenile pink salmon index from Icy Strait one year prior. (Pink salmon fry index data provided by Joe Orsi, NOAA Auke Bay Laboratory, pers. comm.). The forecast error is a proportion calculated by dividing the forecast error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

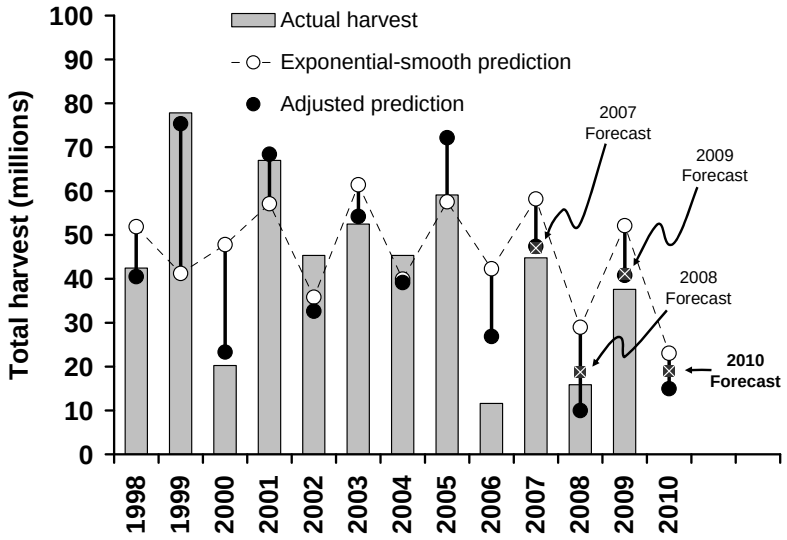

Figure 3. Annual harvest of pink salmon in Southeast Alaska, 1998–2009, compared to the exponential smoothed hindcast predictions of the harvest adjusted using NOAA Auke Bay Laboratory juvenile pink salmon data. The 2007–2009 ADF&G harvest forecasts were very close to the actual harvests in those years. The 2010 forecast of 19 million pink salmon is the average of the exponential-smooth prediction (22 million; white circle) and the adjusted prediction (15 million; black circle).

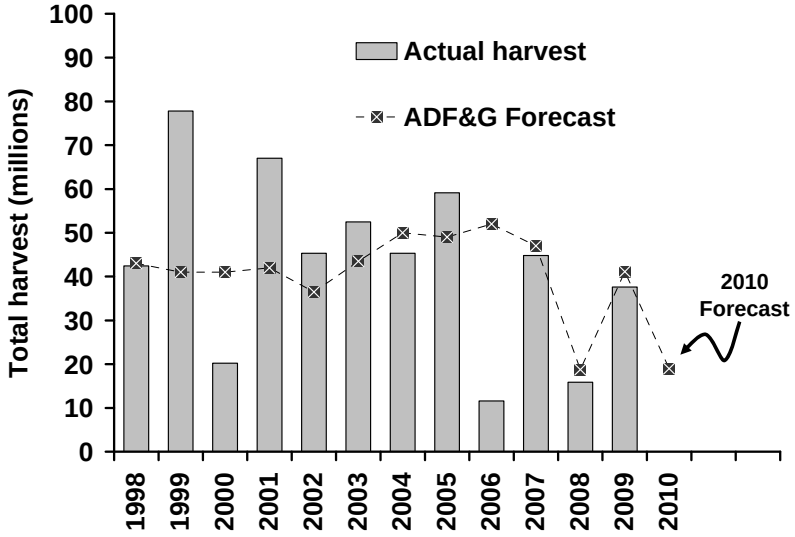

Figure 4. Annual harvest of pink salmon in Southeast Alaska compared to the ADF&G pre-season harvest forecast, 1998–2009. The 2007–2009 ADF&G harvest forecasts were adjusted using NOAA's juvenile pink salmon data.