2015 Alaska Department of Fish and Game Southeast Alaska Pink Salmon Harvest Forecast

The Southeast Alaska pink salmon harvest in 2015 is predicted to be in the *excellent* range with a point estimate of **58 million fish (80% confidence interval: 37–79 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 over the 51-year period 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 2015 forecast was produced in two steps: 1) a forecast of the trend in harvest, and 2) the forecast trend adjusted using 2014 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 0.22 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. This analysis produced a forecast of 46 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 (see Wertheimer et al. 2011[1]) and are highly correlated with the harvest of adult pink salmon in the following year. We developed a simple equation to predict the forecast error in the exponential smooth by regressing the forecast error residuals from 1998 to 2014 on the corresponding NOAA CPUE data from 1997 to 2013 (Figure 2). The forecast error residuals were simply the exponential smooth forecast subtracted from the actual harvest. The predicted forecast error for 2015 was 11.5 million, which, when added to the exponential-smooth forecast, brought the forecast up to 58 million

[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: Wertheimer, A. C., J. A. Orsi, E. A. Fergusson, and M. V. Sturdevant. 2011. Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated environmental parameters: 2010 returns and 2011 forecast (NPAFC Doc. 1343) Auke Bay Lab., Alaska Fish. Sci. Cen., Nat. Mar. Fish. Serv., NOAA, 17109 Point Lena Loop Road, Juneau, AK 99801-8626, USA, 20 p.; http://www.npafc.org/new/pub_documents.html.

pink salmon (Figure 3). The forecast range (37–79 million) is based on an 80% confidence interval calculated from the mean squared error of the adjusted hind-cast predictions.

Forecast Discussion:

Forecasting the 2015 pink salmon harvest was made exceptionally challenging due to the unprecedented harvest of 95 million pink salmon in the parent year of 2013. This harvest was nearly 20 million fish higher than any other pink salmon harvest since commercial fisheries began in Southeast Alaska in the late 1800s. We looked at over a dozen different forecasting models, many of which produced forecasts for 2015 that were near or above this anomalously high harvest, driven primarily by the steep trend in recent odd-year harvests. Although we have typically started our trend analysis with the parent year harvest, we took a more conservative approach for the 2015 forecast and used both odd- and even-year data in our trend analysis. Our decision to be conservative in our trend analysis is supported by the improved fit in the relationship between the NOAA CPUE index and the residuals of the trend analysis using both odd and even years—r^2=0.55 (Figure 2) versus r^2=0.41 for the trend analysis beginning with parent year and only incorporating odd-year data.

The 2015 harvest forecast of 58 million pink salmon is well above the recent 10-year average harvest of 41 million pink salmon, and a harvest of that magnitude would be in the top ten harvests since 1960. The NOAA Auke Bay Lab's 2014 peak June–July juvenile pink salmon CPUE statistic from upper Chatham and Icy straits in northern Southeast Alaska ranked 5th out of the 18 years that they have collected juvenile salmon abundance information, which indicates the very large escapements in 2013 had good spawning success and that there were no major freshwater and early marine survival issues for pink salmon set to return in 2015. Pink salmon harvests associated with juvenile indices similar to the 2014 index (±20%) ranged from 45 to 95 million fish. Perhaps the largest potential source of uncertainty regarding the 2015 pink salmon return is the anomalously warm conditions present in the Gulf of Alaska during the summer of 2014—the effect of these unusual environmental conditions on the marine survival of pink salmon is not known.
http://www.nwfsc.noaa.gov/news/features/food_chain/index.cfm

The NOAA Auke Bay Laboratories continues to conduct research that has greatly improved our ability to forecast pink salmon harvests in Southeast Alaska. NOAA has been using juvenile pink salmon catch and associated biophysical data to forecast adult pink salmon harvest in SEAK since 2004. The 2015 NOAA forecast can be found at the following link:
http://www.afsc.noaa.gov/ABL/EMA/EMA_PSF.htm

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 though 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 ninth consecutive year.

The department will manage the 2015 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.

Andy Piston, Pink and Chum Salmon Project Leader, Ketchikan
Steve Heinl, Regional Research Biologist, Ketchikan

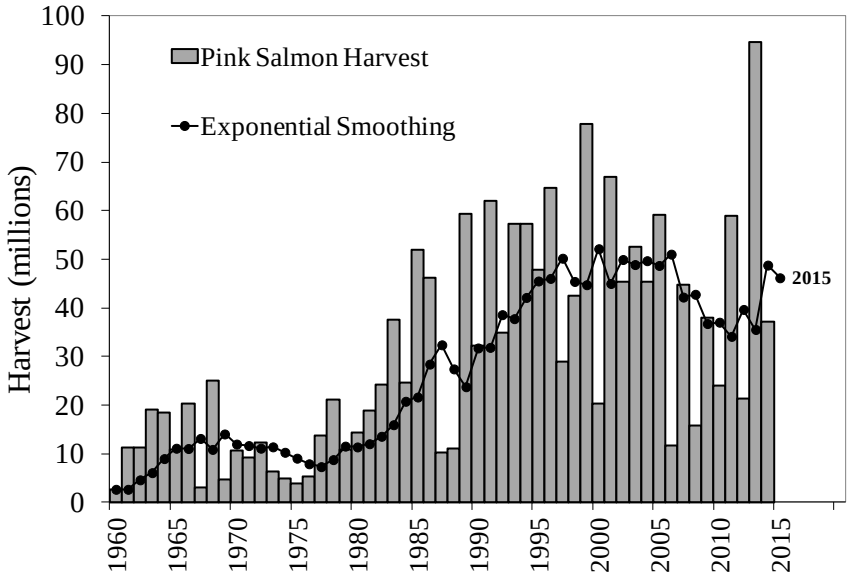

Figure 1. Comparison of the annual harvest of pink salmon in Southeast Alaska, and exponential smoothed hindcast values of the harvest used in the 2015 forecast model. This method produced a 2015 harvest forecast of 46 million pink salmon.

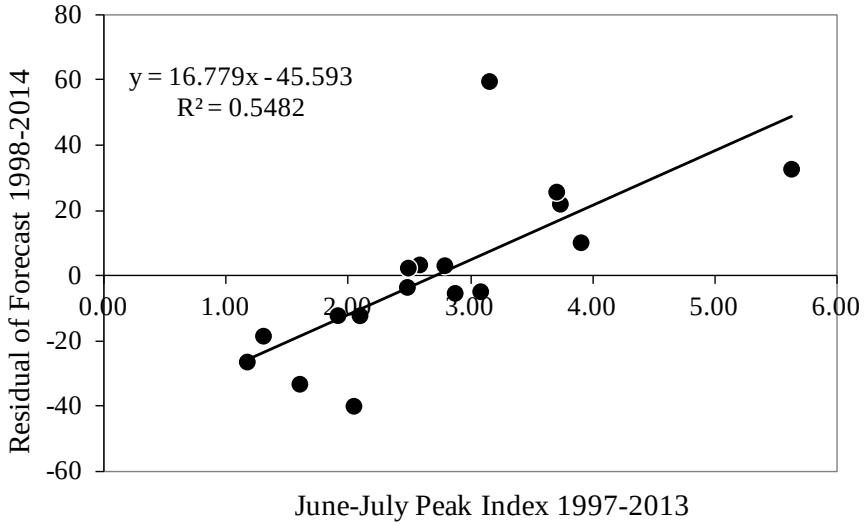

Figure 2. Regression of ADF&G forecast error on the peak June–July juvenile pink salmon CPUE index from Icy Strait one year prior. (Pink salmon fry index data provided by Joe Orsi, NOAA Auke Bay Laboratories, pers. comm.).

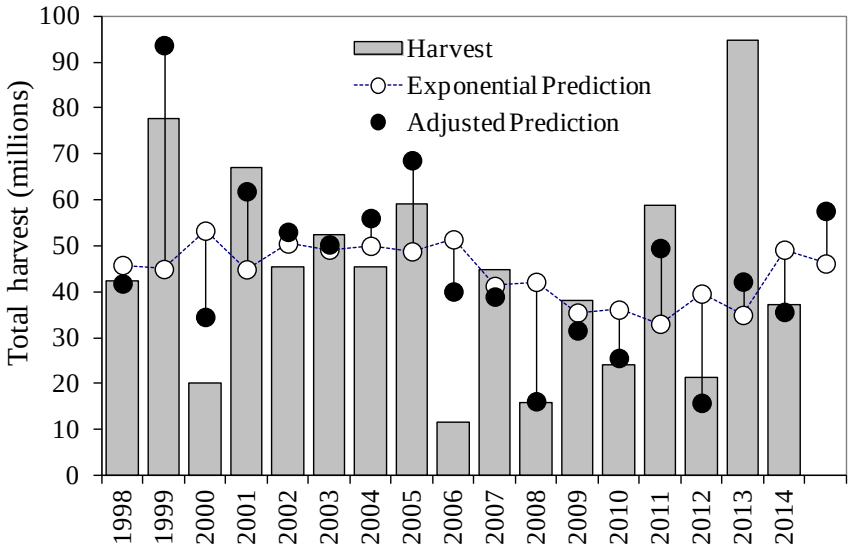

Figure 3. Annual harvest of pink salmon in Southeast Alaska, 1998–2014, compared to the exponential smoothed hindcast predictions of the harvest adjusted using NOAA Auke Bay Laboratories juvenile pink salmon data.

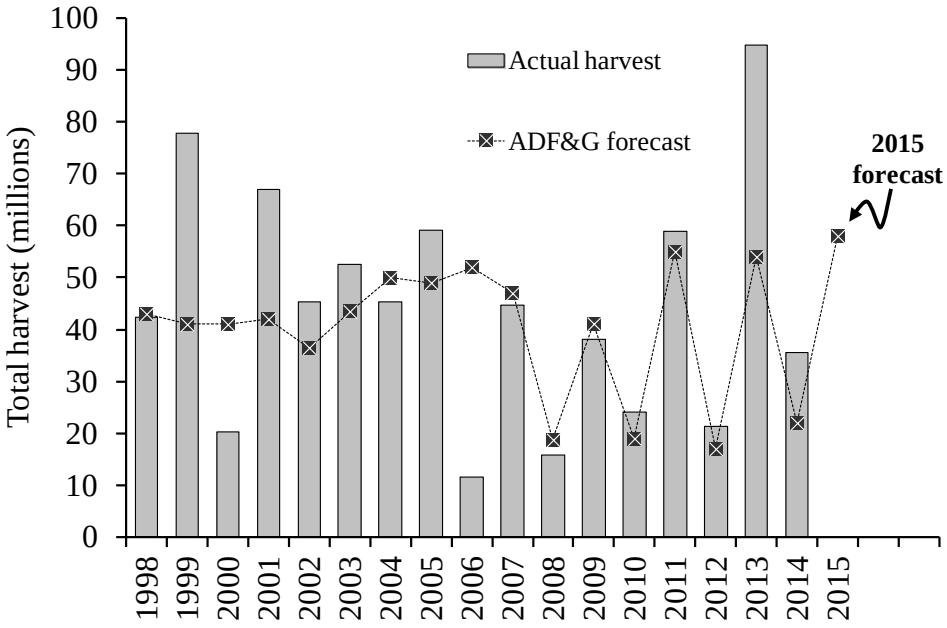

Figure 4. Annual harvest of pink salmon in Southeast Alaska compared to the ADF&G pre-season harvest forecast, 1998–2014. The 2007–2014 ADF&G harvest forecasts were adjusted using NOAA's juvenile pink salmon data.