2016 Alaska Department of Fish and Game Southeast Alaska Pink Salmon Harvest Forecast

The Southeast Alaska pink salmon harvest in 2016 is predicted to be in the *strong* range with a point estimate of **34 million fish (80% confidence interval: 13–55 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 2016 forecast was produced in two steps: 1) a forecast of the trend in harvest, and 2) the forecast trend adjusted using 2015 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 44 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 Wertheimer et al. 2011[1]). We developed a simple equation to predict the forecast error in the exponential smooth by regressing the forecast error residuals from 1998 to 2015 on the corresponding NOAA CPUE data from 1997 to 2014 (Figure 2). The forecast error residuals were simply the exponential smooth forecast subtracted from the actual harvest. The predicted forecast error for 2016 was -9.8 million, which, when added to the exponential-smooth forecast, dropped the forecast to 34

[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.

million pink salmon (Figure 3). The forecast range (13–55 million) is based on an 80% confidence interval calculated from the mean squared error of the adjusted hind-cast predictions.

Forecast Discussion:

The 2016 harvest forecast of 34 million pink salmon is below the recent 10-year average harvest of 38 million pink salmon. The NOAA Auke Bay Lab's 2015 peak June–July juvenile pink salmon CPUE statistic from upper Chatham and Icy straits in northern Southeast Alaska ranked 13th out of the 19 years that they have collected juvenile salmon abundance information. Pink salmon harvests associated with juvenile indices similar to the 2015 index (±20%) ranged from 12 to 45 million fish.

Perhaps the largest potential source of uncertainty regarding the 2016 pink salmon return are the anomalously warm sea surface temperatures that have persisted throughout the Gulf of Alaska since fall 2013. Pink salmon that went to sea in 2014 returned in numbers well below expectation in 2015, particularly in the southern half of the region. Pink salmon that went to sea in 2015 (and set to return in 2016) experienced similar above-average sea surface temperatures. There were also widespread reports of more southern species in the eastern Gulf of Alaska in 2015 (e.g., albacore, American shad, market squid, ocean sunfish, Pacific bonito, Pacific pompano, skipjack tuna, et al.), suggesting pink salmon may experience more competition or predation than normal. Another reason to expect the harvest could be below average in 2016 is the recent poor performance of even-year returns to northern inside waters. The harvest averaged 3 million fish over the past five even years and was only one million fish in the two most recent even years. In addition, escapement indices were below management targets for 17 of 21 northern inside pink salmon stock groups in 2014, which may help perpetuate continued poor harvests in northern inside waters.

The NOAA Auke Bay Laboratories continues to conduct research that has 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 2016 NOAA forecast can be found at the following link: http://www.afsc.noaa.gov/ABL/EMA/EMA_PSF.htm. ADF&G forecasts have been adjusted using NOAA's juvenile pink salmon data since 2007. Although forecast performance was poor for the past three seasons (Figure 4), overall performance since 2007 is much improved (mean absolute percent error = 26%) over forecasts made prior to 2007 (mean absolute percent error = 58%), and recent forecasts have performed better than naïve forecasting models (e.g., 3-year running average, brood-year average harvest, unadjusted exponential smooth, etc.). Hindcasts of past harvests (1998–2006) using our current forecast method exhibited good performance in predicting the direction of forecast error (Figure 3). Even though hindcasts 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 tenth consecutive year.

The department will manage the 2016 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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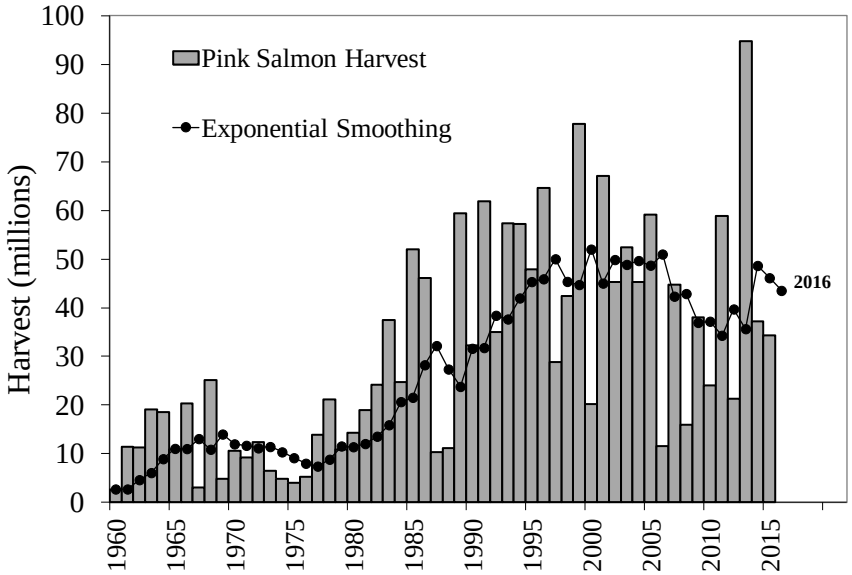

Figure 1. Comparison of the annual harvest of pink salmon in Southeast Alaska, and exponential smoothed hindcast values of the harvest used in the 2016 forecast model. This method produced a 2016 harvest forecast of 44 million pink salmon.

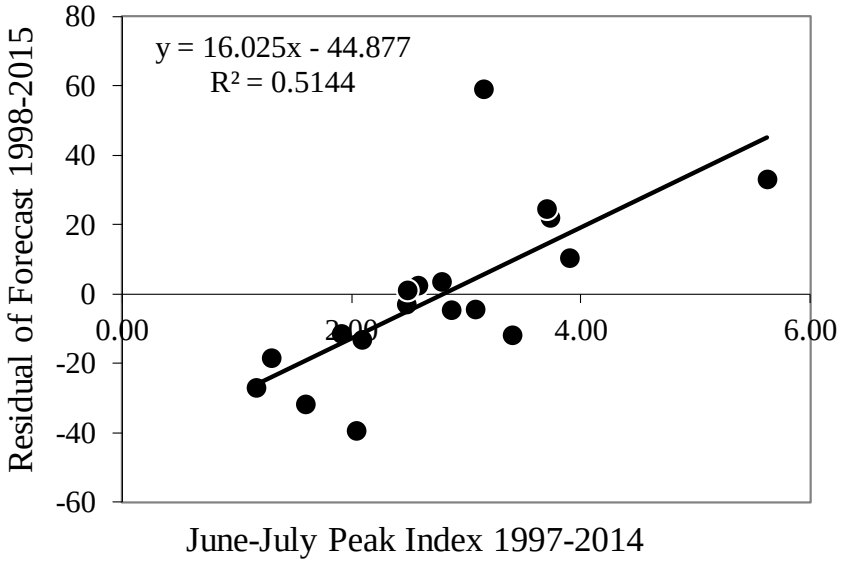

Figure 2. Regression of ADF&G forecast error on the peak June–July juvenile pink salmon CPUE index from Icy Strait one year prior. (Pink salmon fry index data provided by Joe Orsi, NOAA Auke Bay Laboratories, pers. comm.).

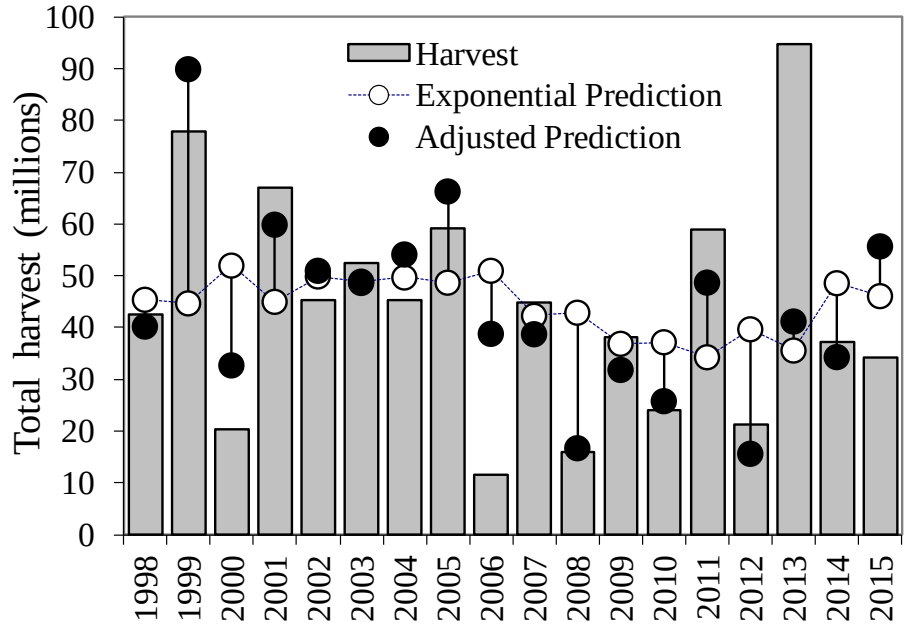

Figure 3. Annual harvest of pink salmon in Southeast Alaska, 1998–2015, compared to the exponential smoothed hindcast predictions of the harvest adjusted using NOAA Auke Bay Laboratories juvenile pink salmon data.

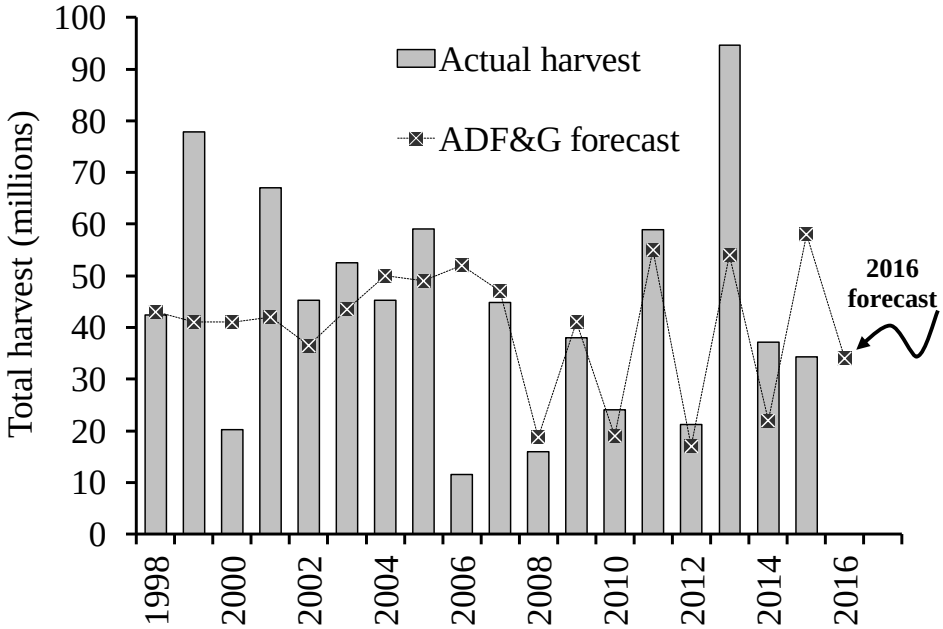

Figure 4. Annual harvest of pink salmon in Southeast Alaska compared to the ADF&G pre-season harvest forecast, 1998–2015. The 2007–2016 ADF&G harvest forecasts were adjusted using NOAA's juvenile pink salmon data.