2014 Alaska Department of Fish and Game Southeast Alaska Pink Salmon Harvest Forecast

The Southeast Alaska pink salmon harvest in 2014 is predicted to be in the *average* range with a point estimate of **22 million fish (80% confidence interval: 8–36 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 2014 forecast was produced in two steps: 1) a forecast of the trend in harvest, and 2) the forecast trend adjusted using 2013 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 2012, the parent year for the 2014 return. Since the formula used to calculate the 2014 forecast is a weighted average of the 2012 harvest and its associated forecast, which was also based on the associated parent year harvest and forecast, the 2014 forecast is based entirely on even-year data. That is, we used all of the even-year harvest data up to 2012, assuming that the 2012 parent year and other even years in the series will better predict the 2014 return. 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-distance-trawled (CPDT) 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

[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.

the exponential smooth by regressing the forecast error proportions from 1998 to 2013 on the corresponding NOAA CPDT data from 1997 to 2012 (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. The predicted forecast error for 2014 was -3%, which resulted in only a slight adjustment to the exponential-smooth forecast—the forecast rounded to the nearest million remained at 22 million pink salmon (Figure 3). The forecast range (8–36 million) is based on an 80% confidence interval calculated by cross-validation estimates of the forecast error.

Forecast Discussion:

The 2014 harvest forecast of 22 million pink salmon is well below the recent 10-year average harvest of 41 million pink salmon, but is close to the average harvest over the past five even years (24 million pink salmon). The primary reason to expect that the harvest in 2014 will be below the recent 10-year average is that biological escapement goals were met in only two of three subregions in the 2012 parent year. The Northern Southeast Inside Subregion escapement index was below goal and management targets were not met in 12 of this subregion's 21 stock groups. Overall, management targets for pink salmon were not met in 5 of 15 districts, and, at a finer scale, 15 of 46 pink salmon stock groups. However, the NOAA Auke Bay Lab's 2013 peak June–July juvenile pink salmon CPDT statistic from upper Chatham and Icy straits in northern Southeast Alaska ranked 10th out of the 17 years that they have collected juvenile salmon abundance information, which may indicate good freshwater and early marine survival for pink salmon set to return in 2014 and perhaps an increase in abundance over recent even-year returns. Pink salmon harvests associated with juvenile indices similar to the 2013 index (±10%) ranged from 24 to 52 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. NOAA has been using juvenile pink salmon catch and associated biophysical data to forecast adult pink salmon harvest in SEAK since 2004. The 2014 NOAA forecast can be found at the following link:
http://www.afsc.noaa.gov/ABL/MSI/msi_sae_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 an eighth consecutive year.

The department will manage the 2014 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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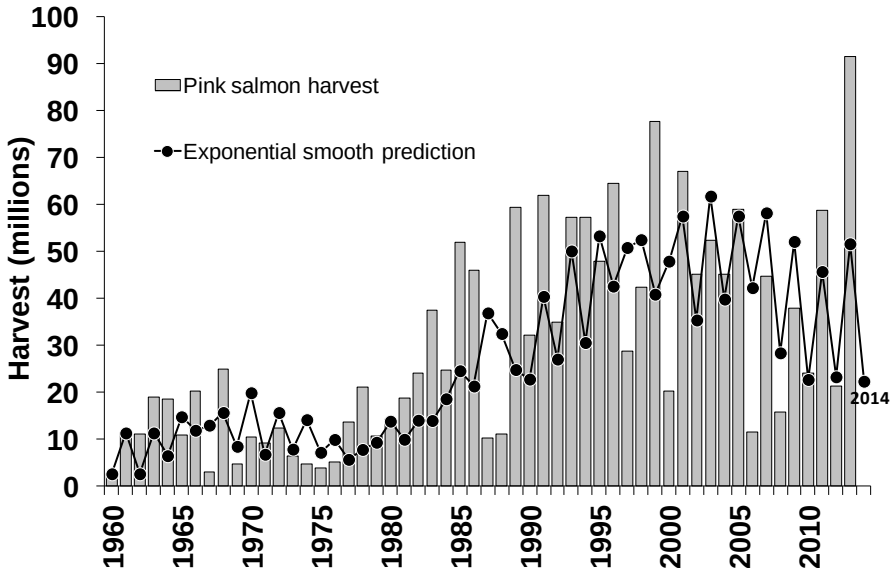

Figure 1. Comparison of the annual harvest of pink salmon in Southeast Alaska, and exponential smoothed hindcast values of the harvest used in the 2014 forecast model. This method produced a 2014 harvest forecast of 22 million pink salmon.

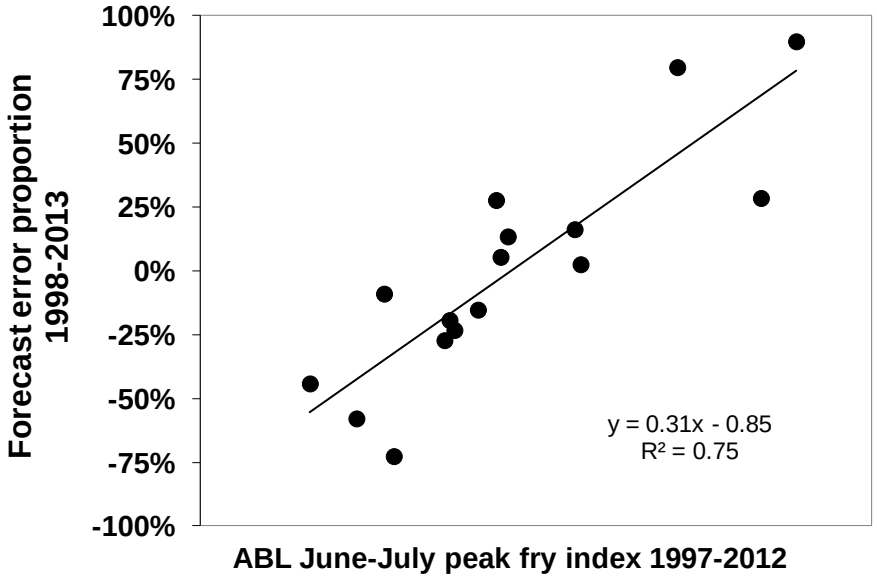

Figure 2. Regression of ADF&G forecast error proportion on the peak June–July juvenile pink salmon CPDT index from Icy Strait one year prior. (Pink salmon fry index data provided by Joe Orsi, NOAA Auke Bay Laboratories, pers. comm.). The forecast error is a proportion calculated by dividing the forecast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

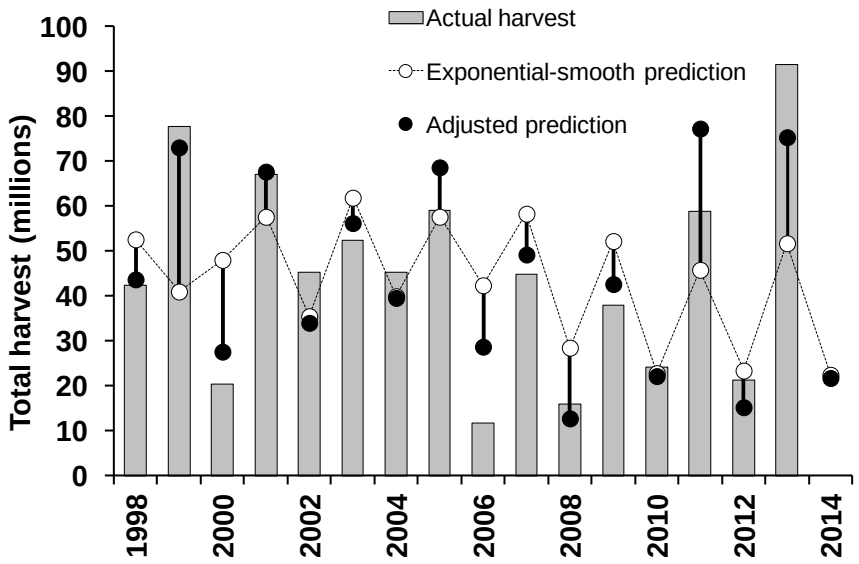

Figure 3. Annual harvest of pink salmon in Southeast Alaska, 1998–2013, compared to the exponential smoothed hindcast predictions of the harvest adjusted using NOAA Auke Bay Laboratories juvenile pink salmon data.

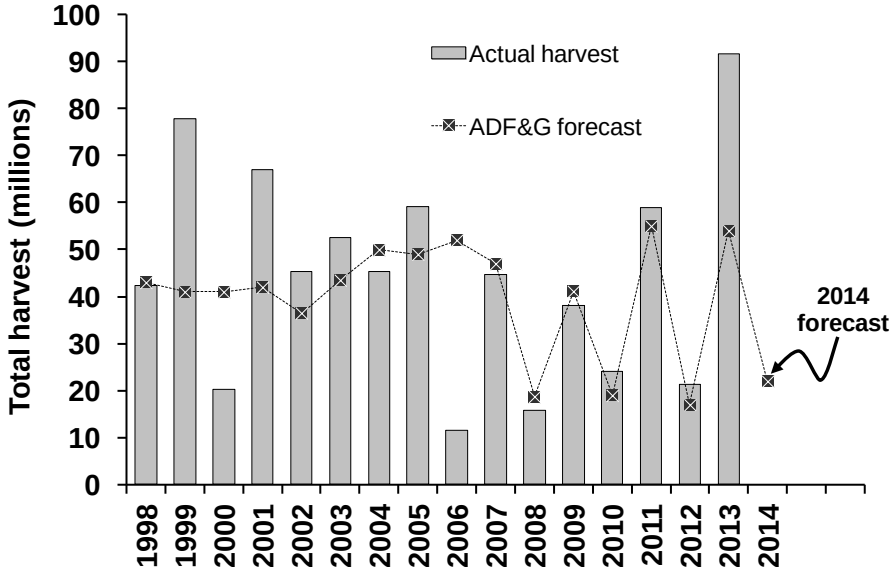

Figure 4. Annual harvest of pink salmon in Southeast Alaska compared to the ADF&G pre-season harvest forecast, 1998–2013. The 2007–2014 ADF&G harvest forecasts were adjusted using NOAA's juvenile pink salmon data.