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Advisory Announcement
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2022 NOAA FISHERIES-ALASKA DEPARTMENT OF FISH AND GAME SOUTHEAST ALASKA PINK SALMON HARVEST FORECAST

The Southeast Alaska (SEAK) pink salmon harvest in 2022 is predicted to be in the *weak* range with a point estimate of **16 million fish (80% prediction interval: 10–24 million fish).** The categorical ranges of pink salmon harvest in SEAK were formulated from the 20th, 40th, 60th, and 80th percentiles of historical harvest over the 61-year period 1960–2020:

Category	Range (millions)	Percentile
Poor	Less than 11	Less than 20th
Weak	11 to 19	20th to 40th
Average	19 to 32	40th to 60th
Strong	32 to 48	60th to 80th
Excellent	Greater than 48	Greater than 80th

Forecast Methods

The NOAA Alaska Fisheries Science Center, Auke Bay Laboratories (NOAA) initiated the Southeast Alaska Coastal Monitoring (SECM) project in 1997 to better understand the effects of climate and nearshore ocean conditions on year class strength of salmon and ecologically related species (Orsi et al. 2000). Since 2018, the SECM project has been conducted cooperatively by NOAA and the Alaska Department of Fish and Game (ADF&G), and the two agencies have combined efforts to produce a joint pink salmon harvest forecast using SECM data (Piston et al. 2019). The ADF&G research vessel *Medeia* is used to conduct the SECM surveys and biologists from NOAA, ADF&G, and the regional aquaculture associations provided direct assistance to the sampling effort during the June and July surveys. We plan to continue working towards increased coordination between agencies and will continue to look for ways to focus and expand the SECM survey to provide a wide variety of valuable information to the fishing industry.

The 2022 SEAK pink salmon harvest forecast (Figures 1 and 2) was primarily based on juvenile pink salmon abundance indices collected by the SECM project in northern SEAK inside waters. These data were obtained from systematic surveys conducted annually in June and July in upper Chatham and Icy Straits and are highly correlated with the harvest of adult pink salmon in the following year (Wertheimer et al. 2011). The 2021 juvenile pink salmon abundance index (monthly peak juvenile CPUE; standardized catch based on 20-minute trawl sets) of 0.88 was the second lowest index in the 25 years of SECM surveys.

Forecasts were developed using an approach described by Murphy et al. (2019). A multiple regression model was developed using the juvenile pink salmon abundance index and temperature. The model used is:

$$E(y) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

where *E(y)* is the expected value for y, the natural log of SEAK pink salmon harvest, β_1 is the coefficient for the natural log of CPUE +1, β_2 is the coefficient for water temperature (e.g., May–July water temperature index in the upper 20 m in Icy Strait), and ε represents the normally distributed error term. The model performance metric one-step-ahead mean absolute percent error (for the last 5 years), and significant coefficients (i.e., covariates) were used to evaluate the forecast accuracy of the two models considered (one with a temperature variable and one without). The 80% prediction interval around the forecast was calculated using the *car* package (Fox and Weisberg 2019) in program R version 3.6.3 (R Core Team 2020).

Forecast Discussion

The 2022 harvest forecast of 16 million pink salmon is approximately half of the recent 10-year average harvest of 34 million pink salmon. A forecast of 16 million pink salmon is an improvement over the previous even-year harvest in 2020 (8 million) and is just below the average even-year harvest since 2006 (18 million). The 2021 peak June–July juvenile pink salmon index value (0.88) ranked 24th out of the 25 years that SECM information has been collected. Pink salmon harvests associated with juvenile indices below 2.0 have ranged from 8 to 21 million fish (mean=16 million fish).

The extremely low juvenile abundance index in 2021 may reflect low escapements of pink salmon in northern inside waters in 2020 and/or poor freshwater and early marine survival in SEAK. Pink salmon escapements in the parent year (2020) were poor throughout northern SEAK inside waters and the escapement goal was not met in that subregion. Conversely, pink salmon escapement goals for the Southern Southeast and Northern Southeast Outside subregions were met, and most of the low harvest of 8 million pink salmon occurred in the southern half of the region. A potential reason to be more optimistic about the 2022 pink salmon return is that juvenile pink salmon heading to sea in 2021 did not experience the anomalously warm sea surface temperatures that persisted throughout the Gulf of Alaska from fall 2013 through much of 2016 (Bond et al. 2015; Di Lorenzo and Mantua 2016; Walsh et al. 2018) and in 2018 and 2019[1]. (Sea surface temperatures were similarly cooler for fish that went to sea in 2020 and returned in above-average numbers in 2021.) Sea surface temperatures were near or below average in the summer and fall of 2021 through much of the Gulf of Alaska, and the summer water temperature index in the upper 20 m in Icy Strait was slightly below average indicating moderate marine temperatures for juvenile salmon heading to sea in 2021.

Although the forecast for 2021 indicated that pink salmon run strength would improve over the parent year, our forecast did not capture the magnitude of the increase in run size (Figure 2). The reason for the under forecast of the 2021 harvest is unknown but may be related to improved offshore survival in the Gulf of Alaska, nonproportional regional representation of juvenile salmon in trawl catches, and/or additional local or basin-scale measures of the environment, unaccounted for in the model, that may better serve as indicators of processes that influence pink salmon survival. If improved survival in the Gulf of Alaska was the primary cause of the under forecast in 2021, the continued cool conditions in the Gulf of Alaska may result in a better-than-expected pink salmon run in 2022. Juvenile pink salmon caught in the 2021 SECM survey trawls were below the average size (in length) for the 25-year time series (Figure 3) and further growth and survival will depend on favorable resources in the Gulf of Alaska.

Temperature has been included in most historical NOAA pink salmon forecast models and several different measures of temperature have been used since 2004 (Wertheimer et al. 2013). Temperature is a significant negative covariate in the forecast model. The negative linear relationship between temperature and harvest, as well as the positive effect of temperature on pink salmon growth, suggests that temperature may impact forecasts through effects on juvenile distribution and migration (Murphy et al. 2019). In 2020 and 2021, we began exploring the potential use of satellite temperature data (available from the NOAA National Environmental Satellite data and Information Service[2]) in our forecast models and may incorporate this type of data in our 2023 harvest forecast. Satellite data allows for averaging of temperature readings over an almost infinite variety of temporal and geographic units. Despite the uncertainties that surround every salmon forecast, the track record of our pink salmon harvest forecasts has been relatively good (Figure 2), especially considering the difficulties unique to forecasting pink salmon runs (Haeseker et al. 2005).

[1] https://www.ncdc.noaa.gov/data-access/marineocean-data/extended-reconstructed-sea-surface-temperature-ersst-v5.
[2] https://www.nesdis.noaa.gov/

The department will manage the 2022 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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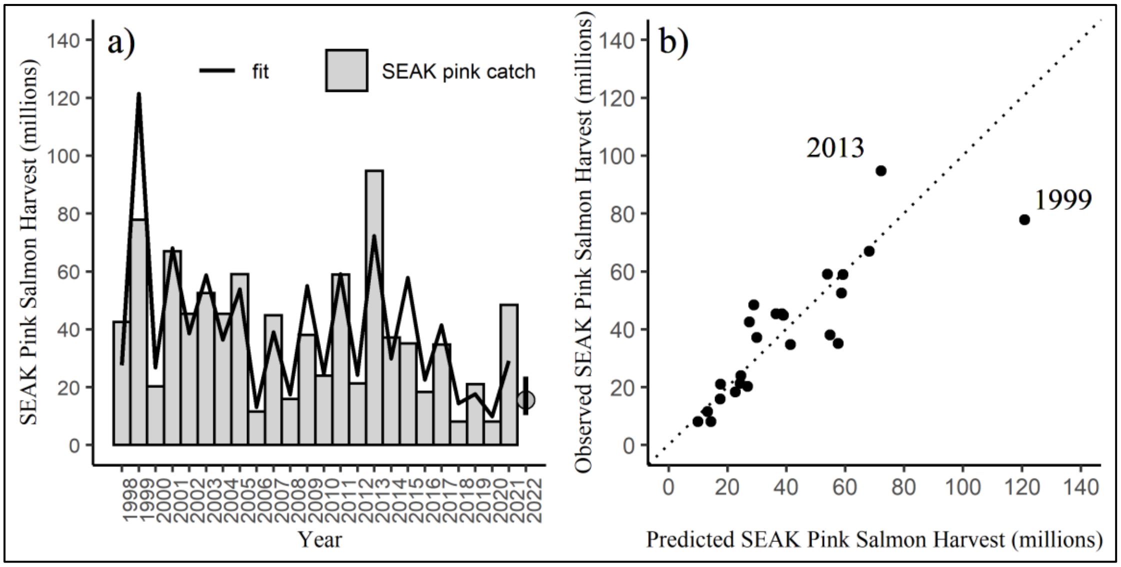

Figure 1. Forecast model fit (hindcasts) for total Southeast Alaska (SEAK) pink salmon harvest, 1998–2021 by year (A) and by the fitted values (B). In panel A, the 2022 forecast is shown as a grey circle with the 80% prediction interval as a black vertical line. The observed SEAK pink salmon harvest is represented by the grey bars and the model fit is shown by the black line. In panel B, the dotted line represents a one-to-one line; circles above the line represent hindcasts that would have been less than the actual harvest and circles below the line represent hindcasts that would have been more than the actual harvest.

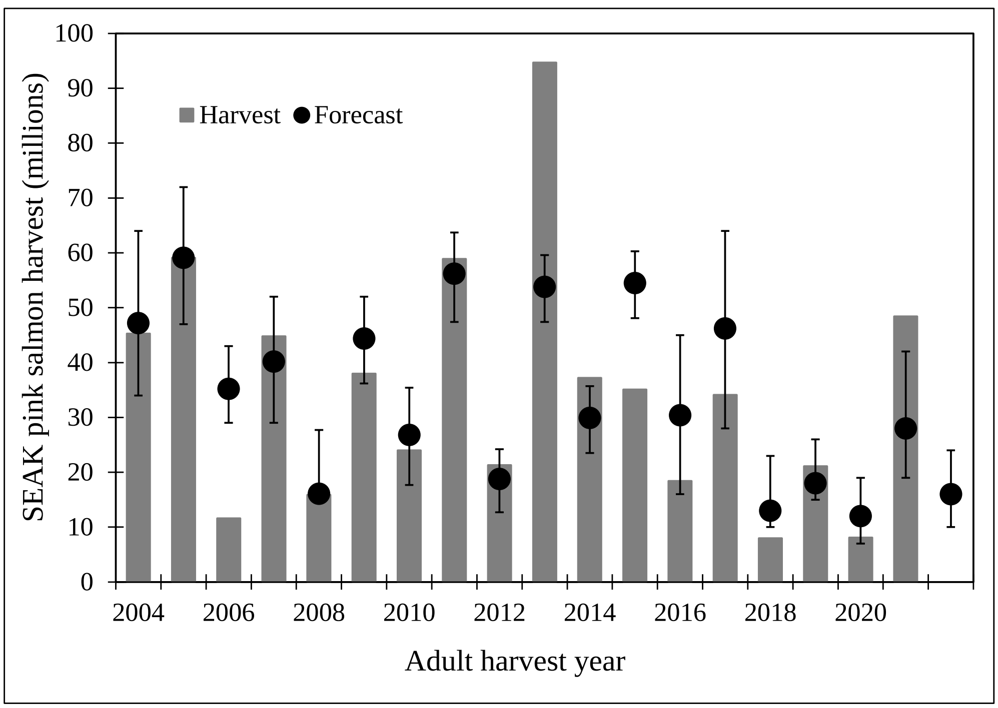

Figure 2. Annual harvests of pink salmon in SEAK compared to the actual preseason harvest forecasts, 2004–2022. The error bars represent the 80% confidence or prediction intervals of the forecasts.

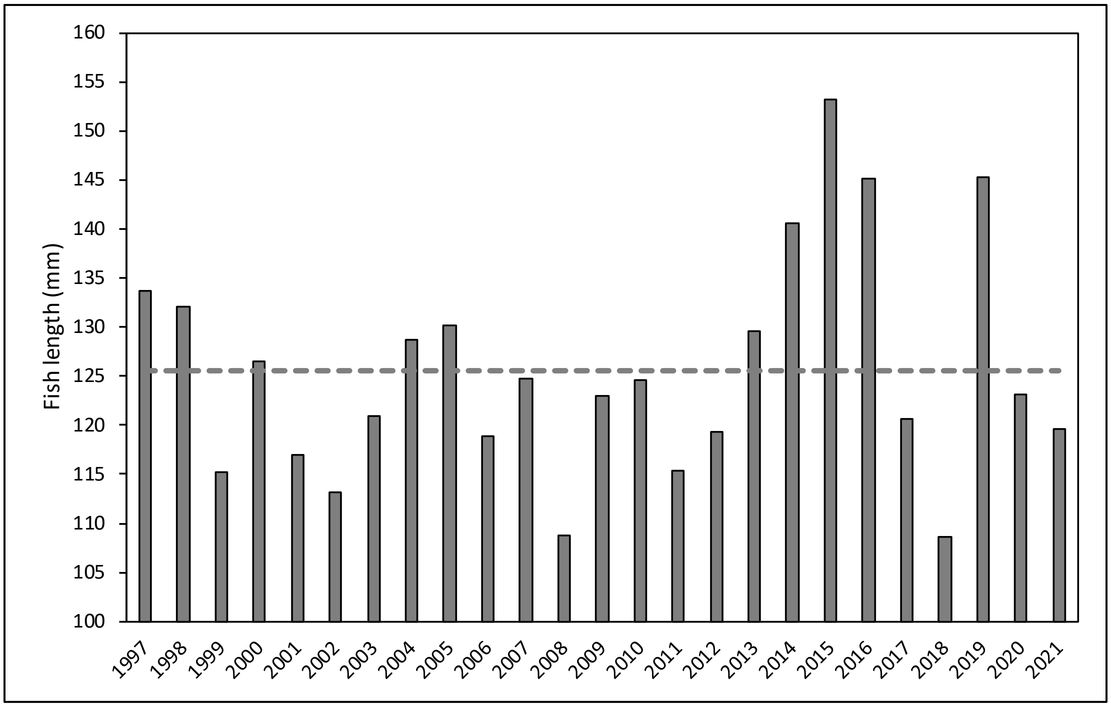

Figure 3. Estimated mean fork length on a standard date (July 24th) of juvenile pink salmon captured during trawl surveys in Upper Chatham and Icy Straits, 1997-2021. Mean fork length was estimated within each year using a linear regression of length by date. The dashed line is the mean for the entire time series.

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