

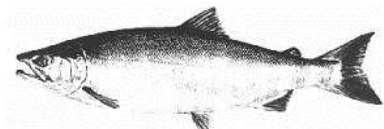
# ALASKA DEPARTMENT OF FISH AND GAME

## DIVISION OF COMMERCIAL FISHERIES

### NEWS RELEASE



*Douglas Vincent-Lang, Acting  
Commissioner*  
*Forrest R. Bowers, Acting Director*



Contact:  
Stormy Haught, PWS Finfish Research Biologist  
Stacy Vega, PWS Finfish Management/Research Biologist  
Phone: (907) 424-3212  
Fax: (907) 424-3235

Cordova ADF&G  
401 Railroad Avenue  
PO Box 669  
Cordova, AK 99574  
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#### 2019 PRINCE WILLIAM SOUND AND COPPER RIVER SALMON FORECAST

This news release provides Prince William Sound (PWS) Area salmon forecasts for 2019. Forecasts of total run were calculated for Copper River Chinook and sockeye salmon, Gulkana Hatchery sockeye salmon, Coghill Lake sockeye salmon, and for wild PWS pink and chum salmon. Prince William Sound Aquaculture Corporation (PWSAC) and Valdez Fisheries Development Association (VFDA) provide additional forecasts for hatchery-specific stocks. In addition to forecasts, a summary of recent 10-year averages (2009–2018) of Commercial Common Property Fishery (CCP) harvest for most wild stocks and Gulkana Hatchery production are also included. Salmon forecasts are inherently uncertain and are primarily used to gauge the magnitude of expected runs and set early-season harvest management strategy. In 2019, the department will continue to manage PWS Area commercial salmon fisheries *inseason* based on the strength of salmon abundance indices including sonar counts, weir passage, aerial escapement surveys, and fishery performance data.

#### 2019 Prince William Sound Area Formal Salmon Forecast Summary (thousands of fish)

Area/Production Type	Species	Forecast Type	Forecast Point	Forecast Range	% Above/Below 10-yr Average
<b>Copper River</b>					
<i>Wild Production</i>	Chinook Salmon	Total Run	55	33–77	19.6% Above
<i>Wild Production</i>	Sockeye Salmon	Total Run	1,416	1,031–1,801	30.9% Below
<i>Gulkana Hatchery Production</i>	Sockeye Salmon	Total Run	98	71–125	69.3% Below
<i>Total Production</i>	Sockeye Salmon	Total Run	1,514	1,021–2,007	
<b>Coghill Lake</b>					
<i>Wild Production</i>	Sockeye Salmon	Total Run	473	280–666	193.8% Above
<b>Prince William Sound</b>					
<i>Wild Production</i>	Pink Salmon	Total Run	23,560	13,920–33,200	67.7% Above
<i>Wild Production</i>	Chum Salmon	Total Run	527	275–779	10.0% Above

2019 COPPER RIVER CHINOOK SALMON FORECAST SUMMARY

The 2019 Copper River Chinook salmon total run point estimate is **55,000 fish (80% confidence interval: 33,000–77,000 fish)**. The recent 10-year average (2009–2018) Copper River Chinook salmon total run is 46,000 fish. Subtracting the lower bound sustainable escapement goal of 24,000 fish from the total run forecast results in a common property harvest point estimate (all fisheries) of **31,000 fish (range: 9,000–53,000 fish)**.

## FORECAST METHODS

Several forecast methods were examined for the 2019 Copper River Chinook salmon total run forecast including exponential smoothing, and 2-, 3-, and 5-year running averages of total run. Total run size was calculated as the sum of commercial and subsistence harvests of Chinook salmon below Miles Lake and the mark-recapture point estimate of Chinook salmon inriver abundance. There are currently 20 years (1999–2018) of inriver abundance estimates available for this analysis. Following a 2018 biometric review of PWS area salmon forecast methods, the department concluded that running average models consistently outperformed more complex sibling models to forecast Copper River Chinook salmon.

For 2019, exponential smoothing and moving average models all produced similar forecast results in the 48,000–58,000 fish range. Exponential smoothing and 2-year running average forecasts had similar performance and outperformed 3- and 5-year running average models when compared retrospectively. The exponential smoothing forecast was selected for 2019 because it marginally outperformed the 2-year running average forecast by having a slightly lower mean absolute percentage error (MAPE) and mean squared error (MSE), while the 2-year running average had the lowest mean percent error. The exponential smoothing technique is similar to a running average except that all observations of total run since 1999 were used in the forecast estimate. Recent observations of total run were weighted more heavily in the analysis while past total run observations were increasingly down-weighted with time, resulting in older total run observations having less influence on the forecast than more recent observations. The 80% confidence intervals were calculated from the mean squared error of the retrospective forecast predictions.

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2019 COPPER RIVER SOCKEYE SALMON FORECAST SUMMARY

The 2019 wild Copper River sockeye salmon total run point estimate is **1,416,000 fish (80% prediction interval: 1,031,000–1,801,000 fish)**. The recent 10-year average (2009–2018) Copper River wild sockeye salmon total run is 2,049,000 fish. Gulkana Hatchery sockeye salmon total run is predicted to be **98,000 fish (80% prediction interval: 71,000–125,000 fish)** for a total Copper River sockeye salmon run (wild + hatchery production) of **1,514,000 fish (80% prediction interval: 1,021,000–2,007,000 fish)**. Total Copper River sockeye salmon common property harvest (all fisheries) is predicted to be **955,000 fish (80% prediction interval: 550,000–1,360,000 fish)** with a CCP harvest of **756,000 fish (80% prediction interval: 351,000–1,161,000 fish)**.

## FORECAST METHODS

Forecast models examined for wild Copper River sockeye salmon for 2019 included mean total run size estimates (2-, 3-, 4-, 5-, 10-, and all-year averages), mean return of individual age classes, and regression models of sibling relationships. Historically, sibling relationship models out-perform more simplistic average run models for Copper River sockeye salmon. The forecast of wild sockeye salmon to the Copper River is the total of estimates for six age classes. Linear regression models with log-transformed data were used to predict returns for age-1.2, -1.3 and -2.2 sockeye salmon. These three age classes were predicted from the relationship between returns of each age class and returns of the age class one year younger from the same brood year (sibling model). Predicted return of age-1.1, -0.3, and -2.3 sockeye salmon were calculated as the 5-year (2014–2018) mean return of those age classes. The 2019 run to Gulkana Hatchery was estimated as the recent 3-year average fry-to-adult survival estimate (0.61%) from all Gulkana I and Gulkana II hatcheries releases combined (onsite and remote). The run was apportioned to brood year using a maturity schedule of 17% age-4 and 83% age-5.

The total common property (all fisheries) harvest forecast was calculated by subtracting the Gulkana Hatchery broodstock, hatchery surplus, and wild stock escapement goal needs (upriver and Copper River Delta) from the total run forecast. The CCP harvest estimate was calculated by subtracting inriver goal categories (5 AAC 24.360(b)) and the Copper River Delta spawning escapement goal from the total run forecast. An estimated exploitation rate of 70% was used to project the total harvest of Gulkana Hatchery stocks in 2019. There are currently 54 years (1965–2018) of harvest, escapement, and age composition data available for this analysis. Total run 80% prediction intervals were calculated as the sum of the individual age class forecast point estimates plus/minus the square root of the sum of the squared differences between the age class forecast point estimates and age class forecast 80% prediction intervals.

Historically, the forecast of Copper River sockeye salmon runs has been the most accurate forecast produced for any salmon species in the PWS area. However, the 2018 Copper River sockeye salmon forecast of 1.88 million fish, produced using methods as described above, resulted in an over-forecast in excess of 1 million fish. This forecast is uncertain and should be interpreted with caution as poor runs of many Gulf of Alaska sockeye salmon stocks in 2018 suggest there is considerable likelihood of over-forecasting in 2019.

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2019 COGHILL LAKE SOCKEYE SALMON FORECAST SUMMARY

The 2019 Coghill Lake sockeye salmon total run point estimate is **473,000 fish (80% prediction interval: 280,000–666,000 fish)**. Subtracting the escapement target of 30,000 fish from the total run forecast results in a common property harvest point estimate (all fisheries) of **443,000 fish (range: 250,000–636,000 fish)**. The recent 10-year average (2009–2018) Coghill Lake sockeye salmon total run is 161,000 fish.

## FORECAST METHODS

The sockeye salmon run forecast to Coghill Lake is the total of estimates for five age classes. Total run by year was estimated as the total commercial harvest contribution combined with the Coghill River weir escapement count. A linear regression model with log-transformed data was used to predict returns of age-1.3 sockeye salmon. This linear regression model was parameterized using the historical relationship between returns of age-1.3 sockeye salmon and returns of the age-1.2 fish one year previous (sibling model), which are from the same brood year. For example, the model to predict the return of age-1.3 sockeye salmon in 2019 used the return of age-1.2 fish in 2018 as the input parameter. Predicted returns of age-1.1, -1.2, -2.2, and -2.3 sockeye salmon were calculated as the 2009–2018 mean return of that age class.

Harvest, escapement, and age composition data are available for Coghill Lake sockeye salmon runs since 1962; however, inclusion of escapements prior to the installation of a full weir in 1974 reduced forecast reliability. Therefore, only data collected since 1974 were used. The 80% prediction intervals for the Coghill Lake sockeye salmon total run were calculated using the squared deviations between the 2014–2018 forecasts and actual runs as the forecast variance. Historically, sibling model estimates of age-1.3 returns to Coghill Lake have a much lower MAPE (32%) than the sibling model used to predict returns of age-1.2 fish (79%). Over the previous 10-year period (2009–2018) Coghill Lake sockeye forecasts have an average error of 43% for total run predictions and 15% for commercial harvest predictions, indicating a tendency to over-forecast. The proportion of age-1.2 fish sampled at the Coghill River weir in 2018 was exceptionally high, resulting in a large forecast of age-1.3 fish for 2019. The large forecast of age-1.3 fish in 2019 is the primary driver for the large 2019 total run forecast. Poor temporal coverage of age composition sampling in 2018 due to multiple washouts of the Coghill River weir, as well as poor runs to many Gulf of Alaska sockeye salmon stocks in 2018, add considerable uncertainty to the 2019 forecast.

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2019 PWS ODD-YEAR WILD PINK SALMON FORECAST SUMMARY

The 2019 PWS wild pink salmon total run point estimate is **23,560,000 fish (80% confidence interval: 13,920,000–33,200,000 fish)**. The recent 10 odd-year average (1999–2017) PWS wild pink salmon total run is 14,050,000 fish.

## FORECAST METHODS

Total wild run of pink salmon by year was estimated as the total wild (non-hatchery) contribution to commercial harvests combined with the stream escapement index. The stream escapement index is calculated as the area under the curve of weekly aerial escapement surveys adjusted for estimates of stream life. Beginning in 2015, the number of index streams surveyed was reduced from 214 to 134 streams, and escapement goals were adjusted in 2017 to match the reduced set of index streams. Because of this, estimates of historical total run used in this analysis, as well as forecast estimates of total run, are slightly lower than pre-2017 levels. No adjustments to the escapement index were made for aerial observer efficiency, the proportion of the total escapement represented by the index streams, or the number of hatchery strays in streams. Wild pink salmon contributions to the CCP were estimated by subtracting hatchery contributions from the CCP total. Hatchery contributions were determined from thermal marked otolith recoveries (1997–2017), coded wire tag recoveries (1985–1996), or average fry-to-adult survival estimates multiplied by fry release numbers and estimated exploitation rates (1977–1984).

Several models were examined for the 2019 PWS wild pink total run forecast including exponential smoothing and 2-, 3-, and 5-year running averages of past odd-year total runs. Exponential smoothing and moving average models produced similar forecast results in the 18–26 million fish range. Exponential smoothing and 2-year running average forecasts had very similar performance and out-performed 3- and 5-year running average models when compared retrospectively. The exponential smoothing forecast was selected for 2019 because it marginally outperformed the 2-year running average forecast by having less bias to over- or under-forecast and lower MSE, while the 2-year running average had lower MAPE. The exponential smoothing technique is similar to a running average except that all observations of odd-year total run since 1961 were used in the forecast estimate. Recent observations of total run were weighted more heavily in the analysis while past total run observations were increasingly down-weighted with time, resulting in older total run observations having less influence on the forecast than more recent observations. The 80% confidence intervals were calculated from the mean squared error of the retrospective forecast predictions. The large 2019 forecast of PWS odd-year pink salmon is primarily driven by record runs in 2015 and 2017.

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2019 PWS WILD CHUM SALMON FORECAST SUMMARY

The 2019 PWS wild chum total run point estimate is **527,000 fish (80% confidence interval: 275,000–779,000 fish)**. The recent 10-year average (2009–2018) PWS wild chum salmon total run is 479,000 fish.

## FORECAST METHODS

Total natural run by year was estimated as the total wild (non-hatchery) contribution to commercial harvests combined with the stream escapement index. See pink salmon forecast methods for details on recent changes to assessment and forecast methods. Several models were examined for the 2019 PWS wild chum total run forecast including exponential smoothing and 2-, 3-, and 5-year running averages of past total runs. For 2019, 3-year running average out-performed the other models. Our ability to accurately forecast wild chum salmon stocks is limited by the lack of data available on the wild component of commercial harvest before 2004. CCP harvest contributions of wild stock chum salmon were estimated using pre-hatchery average natural runs (1998–2003) or thermally marked otolith estimates (2004–2018) for each district in PWS. The 80% confidence intervals were calculated from the mean squared error of the retrospective forecast predictions.

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**PWS Area Recent 10-Year (2009–2018) Average CCP Salmon Harvest by Species (thousands of fish)**

<b>Area/Production Type</b>	<b>Chinook</b>	<b>Sockeye</b>	<b>Coho</b>	<b>Pink</b>	<b>Chum</b>	<b>Total</b>
Bering River						
<i>Wild Production</i>	0	2	67	0	0	69
Copper River						
<i>Wild Production</i>	12	1,043	235	37	10	1,337
<i>Hatchery Production</i>	0	204	0	0	0	204
<i>Total Production</i>	12	1,247	235	37	10	1,541
Prince William Sound						
<i>Wild Production</i>	1	176	N/A <sup>a</sup>	10,920 <sup>b</sup>	236	11,333
Area Totals						
<i>Wild Production</i>	13	1,221	302	10,957	246	12,739

<sup>a</sup> Estimates of wild coho salmon harvests are not available due to limited samples of thermally marked coho salmon otoliths from the commercial harvest.

<sup>b</sup> Recent 10-odd-year average CCP harvest (1999–2017).