Advisory Announcement
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2020 Prince William Sound and Copper River Salmon Forecast

Forecasts of total run were calculated for Copper River wild 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 (2010–2019) of Commercial Common Property Fishery (CCP) harvest for most wild stocks and Gulkana Hatchery production is 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 2020, 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.

2020 Prince William Sound Area Salmon Forecast Summary (thousands of fish)

Area/Production Type	Species	Forecast Type	Forecast Point	Forecast Range	% Above/Below 10-yr Average
Copper River					
Wild Production	Chinook Salmon	Total Run	60	39–82	20.0% Above
Wild Production	Sockeye Salmon	Total Run	1,422	903–1,942	32.7% Below
Gulkana Hatchery Production	Sockeye Salmon	Total Run	109	69–149	62.3% Below
Total Production	Sockeye Salmon	Total Run	1,531	972–2,091	
Coghill Lake					
Wild Production	Sockeye Salmon	Total Run	175	81–268	6.4% Below
Prince William Sound					
Wild Production	Pink Salmon	Total Run	4,421	1,197–16,327	18.8% Above
Wild Production	Chum Salmon	Total Run	604	342–865	18.9% Above

2020 COPPER RIVER CHINOOK SALMON FORECAST SUMMARY

The 2020 Copper River Chinook salmon total run point estimate is **60,000 fish (80% prediction interval: 39,000–82,000 fish)**. The recent 10-year average (2010–2019) Copper River Chinook salmon total run is 48,000 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 **36,000 fish (range: 15,000–58,000 fish)**.

FORECAST METHODS

Several forecast methods were examined for the 2020 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 21 years (1999–2019) of inriver abundance estimates available for this analysis.

For 2020, exponential smoothing and moving average models produced similar forecast results in the 53,000–63,000 fish range. Exponential smoothing and 2-year running average forecasts had similar performance and out-performed 3- and 5-year running average models when compared retrospectively. The exponential smoothing forecast was selected for 2020 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 and bias. 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% prediction intervals were calculated from the mean squared error of the retrospective forecast predictions.

2020 COPPER RIVER SOCKEYE SALMON FORECAST SUMMARY

The 2020 wild Copper River sockeye salmon total run point estimate is **1,422,000 fish (80% prediction interval: 903,000–1,942,000 fish)**. The recent 10-year average (2010–2019) Copper River wild sockeye salmon total run is 2,113,000 fish. Gulkana Hatchery sockeye salmon total run is predicted to be **109,000 fish** (**80% prediction interval: 69,000–149,000 fish)** for a total Copper River sockeye salmon run (wild + hatchery production) of **1,531,000 fish (80% prediction interval: 972,000–2,091,000 fish)**. Total Copper River sockeye salmon common property harvest (all fisheries) is predicted to be **970,000 fish (80% prediction interval: 554,000–1,386,000 fish)** with a CCP harvest of **771,000 fish (80% prediction interval: 355,000–1,187,000 fish)**.

FORECAST METHODS

Forecast models examined for wild Copper River sockeye salmon for 2020 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, -2.2, and 2.3 sockeye salmon. These four 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, and -0.3, sockeye salmon were calculated as the 5-year (2015–2019) mean return of those age classes. The 2020 run to Gulkana Hatchery was estimated as the recent 5-year weighted average fry-to-adult survival estimate (0.70%) 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 40% age-4 and 60% 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 2020. There are currently 55 years (1965–2019) of harvest, escapement, and age composition data available for this analysis. Total run 80% prediction intervals were calculated from the mean squared error of the retrospective forecast predictions.

2020 COGHILL LAKE SOCKEYE SALMON FORECAST SUMMARY

The 2020 Coghill Lake sockeye salmon total run point estimate is **175,000 fish (80% prediction interval: 81,000–268,000 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 **145,000 fish (range: 51,000–238,000 fish)**. The recent 10-year average (2010–2019) Coghill Lake sockeye salmon total run is 187,000 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. Linear regression models with log-transformed data were used to predict returns of age-1.3 and -1.2 sockeye salmon. These linear regression models were parameterized using the historical relationship between returns of age-1.3 sockeye salmon and returns of the age-1.2 fish one year previous, and returns of age-1.2 sockeye salmon and returns of the age-1.1 fish one year previous (sibling models). For example, the model to predict the return of age-1.3 sockeye salmon in 2020 used the return of age-1.2 fish in 2019 as the input parameter. Predicted returns of age-1.1, -2.2, and -2.3 sockeye salmon were calculated as the 2010–2019 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 reduce 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 2015–2019 forecasts and actual runs as the forecast variance. Over the previous 10-year period (2010–2019) Coghill Lake sockeye forecasts have an average error of 35% for total run predictions and 12% for commercial harvest predictions.

The number of age-1.1 fish sampled at the Coghill River weir in 2019 was high relative to previous years and resulted in a 2019 age-1.1 Coghill Lake sockeye salmon total run estimate of 11,400, well above the previous record high of 7,500 set in 2017, and well above the recent 10-year average run of 2,500 age-1.1 sockeye salmon to Coghill Lake. The 2019 run of age-1.2 fish (15,400), however, was well below the recent 10-year average (49,500). The high abundance of age-1.1 fish in the 2019 run resulted in a large forecast of age-1.2 fish for 2020 (110,800, 63% of the predicted 2020 total run). For the recent 10-years (2010–2019), the linear regression sibling model predicting the number of age-1.2 Coghill Lake sockeye salmon from the previous year's run of age-1.1 fish has a MAPE of 40.3% and an average error of -4.9%. Coghill Lake sockeye salmon run age structure dominated by age-1.2 fish (>50% of total run) has been observed in 7 years since 1968 (1981, 1995, 1999, 2003, 2006, 2010, and 2018), and during that same time period there have only been 4 years when age-1.2 returns to Coghill Lake have exceeded 100,000 fish (1981, 1999, 2011, 2018).

2020 PWS EVEN-YEAR WILD PINK SALMON FORECAST SUMMARY

The 2020 PWS wild pink salmon total run point estimate is **4,421,000 fish (80% prediction interval: 1,197,000–16,327,000 fish)**. The recent 10 even-year average (2000–2018) PWS wild pink salmon total run is 3,721,000 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 stream escapement indices. The stream escapement index is calculated as the area under the curve of weekly aerial escapement surveys adjusted for estimates of stream life. For this forecast, total run estimates were natural log-transformed. Hatchery and wild stock contributions were determined from thermal marked otolith recoveries (1997–2018), 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 2020 PWS wild pink total run forecast including exponential smoothing and 2-, 3-, and 5-year running averages of past even-year total runs. Exponential smoothing and moving average models produced similar forecast results in the 3.7–4.9 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 2-year running average forecast was selected for 2020 because it marginally outperformed other forecast models by having the lowest bias to over- or under-forecast and the lowest mean percent error and mean squared error. The 80% prediction intervals were calculated from the mean squared error of the retrospective forecast predictions.

The 2020 PWS wild chum total run point estimate is **604,000 fish (80% prediction interval: 342,000–865,000 fish)**. The recent 10-year average (2010–2019) PWS wild chum salmon total run is 508,000 fish.

FORECAST METHODS

Total wild run of chum salmon by year was estimated as the total wild (non-hatchery) contribution to commercial harvests combined with the stream escapement index. Several models were examined for the 2020 PWS wild chum total run forecast including exponential smoothing and 2-, 3-, and 5-year running averages of past total runs. For 2020, 2-year running average out-performed the other models by having the lowest mean absolute percentage error, the lowest mean absolute squared error, and relatively low bias when compared retrospectively. 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% prediction intervals were calculated from the mean squared error of the retrospective forecast predictions.

PWS Area Recent 10-Year (2010–2019) Average CCP Salmon Harvest by Species (thousands of fish)

Area/Production Type	Chinook	Sockeye	Coho	Pink	Chum	Total
Bering River						
Natural Production	0	4	63	0	0	67
Copper River						
Natural Production	13	1,080	223	54	17	1,387
Hatchery Production	0	225	0	0	0	225
Total Production	13	1,305	223	54	17	1,612
Prince William Sound						
Natural Production	1	208	N/A[a]	2,664[b]	279	3,152
Area Totals						
Natural Production	14	1,517	286	2,718	296	4,831

[a] Estimates of wild coho salmon harvests in are not available due to limited samples of thermally marked coho otoliths from the commercial harvest

[b] Recent 10 even-year CCP harvest (2000-2018)