



Advisory Announcement
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2024 Prince William Sound and Copper River Salmon Forecast

Forecasts of total run were calculated for Copper River Chinook salmon, Copper River wild sockeye salmon, Gulkana Hatchery sockeye salmon, Coghill Lake sockeye salmon, and for wild Prince William Sound (PWS) pink and chum salmon. Prince William Sound Aquaculture Corporation and Valdez Fisheries Development Association provide additional forecasts for hatchery-specific stocks. The categorical ranges of total run strength (Table 1) were formulated for each stock from the 20th, 40th, 60th, and 80th percentiles of the recent 10 years (2014-2023 for Chinook, chum, and sockeye salmon and 2004-2022 even years for pink salmon) and are shown in Table 2. Salmon forecasts are inherently uncertain and are primarily used to gauge the general magnitude of expected runs and set early-season harvest management strategy. In 2024, the department will continue to manage PWS and Copper River area commercial salmon fisheries inseason based primarily on the strength of salmon abundance indices including sonar counts, weir passage, aerial escapement surveys, and fishery performance data.

Table 1. Categorical ranges of total run.

Category	Percentile
Poor	Less than 20 th
Weak	20 th to 40 th
Average	40 th to 60 th
Strong	60 th to 80 th
Excellent	Greater than 80 th

Table 2. 2024 Prince William Sound Area salmon run forecasts (thousands of fish), historic comparisons, and percentile category.

Area/Run Type	Species	Forecast Point Estimate	Forecast Range	% Above/Below 10-yr Average	Total Run 10-yr Average	Category
Copper River						
<i>Wild</i>	Chinook salmon	47	34–66	2% Below	48	Average
<i>Wild</i>	Sockeye salmon	1,965	1,572–2,358	13% Above	1,740	Strong
<i>Gulkana Hatchery</i>	Sockeye salmon	36	29–44	69% Below	117	Weak
<i>Total Run</i>	Sockeye salmon	2,001	1,603–2,400	8% Above	1,852	Average

Coghill Lake						
<i>Wild</i>	Sockeye salmon	273	152–395	38% Above	194	Strong
Prince William Sound						
<i>Wild</i>	Pink salmon	6,447	2,219–18,729	50% Above	4,302	Strong
<i>Wild</i>	Chum salmon	639	401–877	27% Above	503	Strong

2024 COPPER RIVER CHINOOK SALMON FORECAST SUMMARY

The 2024 Copper River Chinook salmon total run forecast point estimate is **Average at 47,000 fish (80% prediction interval: 34,000–66,000 fish)**. This is 2% below the recent 10-year average (2014–2023) total run of 48,000 fish. The sustainable escapement goal for Copper River Chinook salmon is 21,000 to 31,000 fish.

FORECAST METHODS

For 2024, the Copper River Chinook salmon state-space model was chosen as the forecast method. This model simultaneously reconstructs runs and fits a spawner-recruit model to estimate total return, escapement, and recruitment of Copper River Chinook salmon from 1999 to 2023. Methods and details of this analysis are covered in separate reports (Joy et al. 2021, Savereide et al. 2018). The model uses harvest, age composition, and direct measures of inriver run abundance to estimate parameters that describe the spawner-recruit relationship for this stock. Uncertainty from the run reconstruction is passed through to the spawner-recruit analysis and all relevant data are considered and weighted by their precision. The model accommodates missing data, measurement error in the data, and changes in age at maturity.

Several forecast methods were examined for the 2024 Copper River Chinook salmon total run forecast including exponential smoothing, 2-, 3-, and 5-year running averages of total run, and projections from the Copper River Chinook salmon state-space model. The state-space model performed similarly when compared retrospectively to the simple average-based methods historically used to forecast this stock, while using more biological information to predict future runs (Table 3). The state-space model outperformed the average-based models by having a lower mean absolute percentage error (MAPE) and mean percentage error (MPE) when compared retrospectively. Total run size in prior years 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 25 years (1999–2023) of inriver abundance estimates available for this analysis. The 80% prediction intervals were calculated from the posterior distributions of the model parameters, including the predicted run-size for 2024.

Copper River Chinook salmon

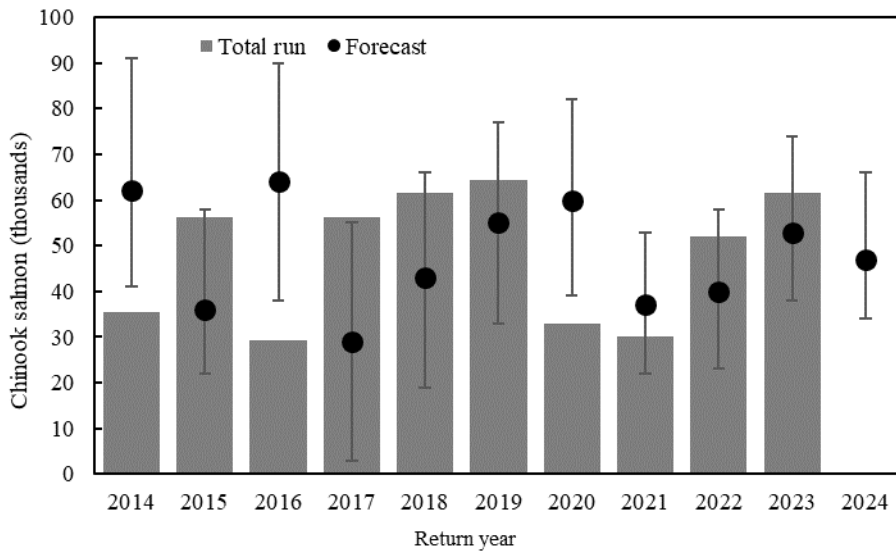


Figure 1. Total run of Copper River Chinook salmon compared to preseason total run forecasts, 2014–2023, and the 2024 forecast. Error bars represent 80% prediction intervals of forecasts.

Savereide, J. W., M. Tyers, and S. J. Fleischman. 2018. Run reconstruction, spawner-recruit analysis, and escapement goal recommendation for Chinook salmon in the Copper River. Alaska Department of Fish and Game, Fishery Manuscript No. 18-07, Anchorage.

Joy, P., J. W. Savereide, M. Tyers, and S. J. Fleischman. 2021. Run reconstruction, spawner-recruit analysis, and escapement goal recommendation for Chinook salmon in the Copper River. Alaska Department of Fish and Game, Fishery Manuscript No. 21-01, Anchorage.

2024 COPPER RIVER SOCKEYE SALMON FORECAST SUMMARY

The 2024 wild Copper River sockeye salmon total run forecast point estimate is **Strong at 1,965,000 fish (80% prediction interval: 1,572,000–2,358,000 fish)**. Gulkana Hatchery sockeye salmon total run is predicted to be **Weak at 36,000 fish (80% prediction interval: 29,000–44,000 fish)**, for a total Copper River sockeye salmon run (wild + hatchery production) of **2,001,000 fish (80% prediction interval: 1,601,000–2,402,000 fish)**. This is 8% above the recent 10-year average (2014–2023) total run of 1,852,000 fish. Total Copper River sockeye salmon harvest estimate (all fisheries) is predicted to be **Average at 1,503,000 fish (80% prediction interval: 1,198,000–1,808,000 fish)** with a commercial harvest of **1,297,000 fish (80% prediction interval: 992,000–1,602,000 fish)**.

FORECAST METHODS

The 2024 forecast of wild sockeye salmon to the Copper River is the sum of individual forecasts 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. Forecasts of these four age classes were developed 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, Table 4). The predicted return of age-1.1, and -0.3, sockeye salmon were calculated as the 5-year (2019–2023) mean return of these age classes. The 2024 run to Gulkana Hatchery was estimated as the recent 5-year weighted average fry-to-adult survival estimate (0.33%) from all Gulkana I and Gulkana II hatchery releases combined (onsite and remote). The Gulkana Hatchery run was apportioned to brood year using a maturity schedule of 30% age-4 and 70% age-5.

The total harvest point estimate (all fisheries) 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 commercial

harvest estimate was calculated by subtracting Copper River inriver goal categories (5 AAC 24.360(b)) and the lower bound of 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 2024. There are currently 59 years (1965–2023) 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.

Copper River sockeye salmon

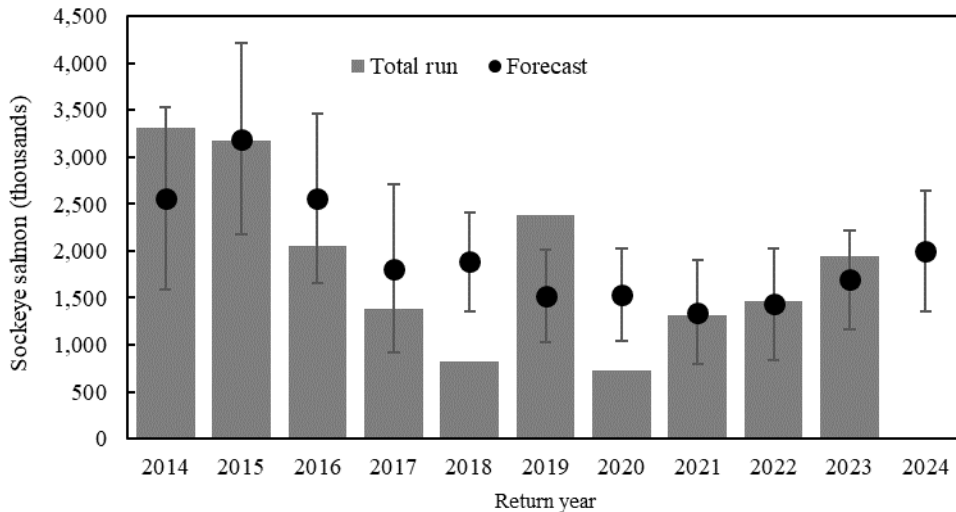


Figure 2. Total run of Copper River sockeye salmon compared to preseason total run forecasts, 2014–2023, and the 2024 forecast. Error bars represent 80% prediction intervals of forecasts.

2024 COGHILL LAKE SOCKEYE SALMON FORECAST SUMMARY

The 2024 Coghill Lake sockeye salmon total run forecast point estimate is **Strong at 273,000 fish (80% prediction interval: 152,000–395,000 fish)**. This is 38% above the 10-year average (2014–2023) total run of 197,000 fish. Subtracting the escapement target of 30,000 fish from the total run forecast results in a harvest point estimate (all fisheries) of **243,000 fish (range: 122,000–365,000 fish)**.

FORECAST METHODS

The 2024 sockeye salmon run forecast to Coghill Lake is the total of estimates for five age classes. Linear regression models with log-transformed data were used to predict returns of age-1.3 and -1.2 sockeye salmon (Table 4). These linear regression models were parameterized using the historical relationship between returns of age-1.3 sockeye salmon and returns of 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 chosen to predict the return of age-1.3 sockeye salmon in 2024 used the return of age-1.2 fish in 2023 as the input parameter. Predicted returns of age-1.1, -2.2, and -2.3 sockeye salmon were calculated as the 2014–2023 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. Total run by year was estimated as the total commercial harvest contribution combined with the Coghill River weir escapement count. The 80% prediction intervals for the Coghill Lake sockeye salmon total run were calculated using the squared deviations between the 2014–2023 forecasts and actual runs as the forecast variance.

Coghill Lake sockeye salmon

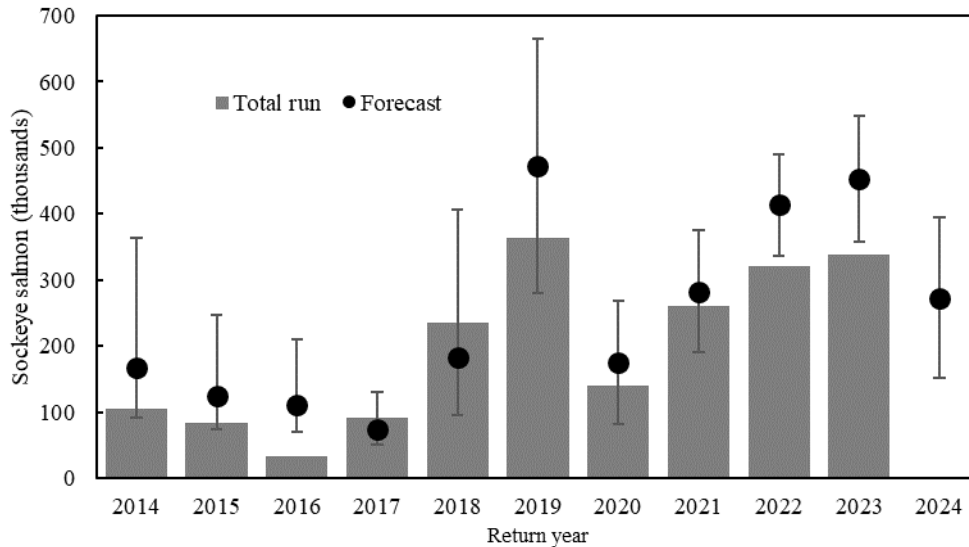


Figure 3. Total run of Coghill Lake sockeye salmon compared to preseason total run forecasts, 2014–2023, and the 2024 forecast. Error bars represent 80% prediction intervals of forecasts.

2024 PWS EVEN-YEAR WILD PINK SALMON FORECAST SUMMARY

The 2024 PWS wild pink salmon total run forecast point estimate is **Strong at 6,447,000 fish (80% prediction interval: 2,219,000–18,729,000 fish)**. This is 50% above the recent 10 even-year average (2004–2022) PWS wild pink salmon total run of 4,302,000 fish. Subtracting the mid-point of the even-year sustainable escapement goal, 783,500, from the total run forecast results in a harvest point estimate of **5,663,000 fish (range: 1,436,000 to 17,946,000)**.

FORECAST METHODS

Several models were examined for the 2024 PWS wild pink salmon total run forecast including exponential smoothing and 2-, 3-, and 5-year running averages of past even-year total runs. The 3-year running average forecast was selected for 2024 because it outperformed other forecast models by having the lowest mean absolute percent error (MAPE) and median symmetrical accuracy (Table 5). The 80% prediction intervals were calculated from the mean squared error of the retrospective forecast predictions.

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. Hatchery and wild stock contributions were determined from thermal marked otolith recoveries (1997–2023), coded wire tag recoveries (1985–1996), or average fry-to-adult survival estimates multiplied by fry release numbers and estimated exploitation rates (1977–1984).

Prince William Sound pink salmon

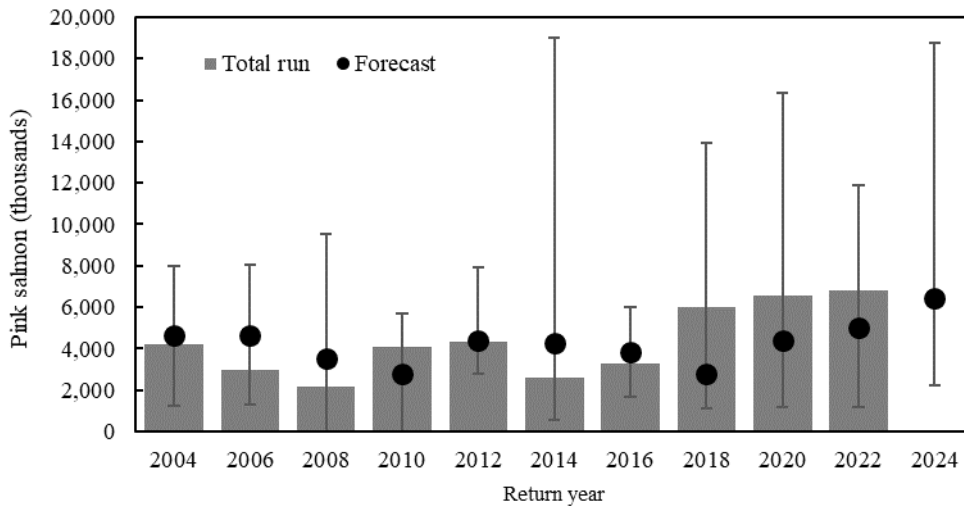


Figure 4. Total run of Prince William Sound wild pink salmon compared to preseason total run forecasts, 2004–2022, and the 2024 forecast. Error bars represent 80% prediction intervals of forecasts.

2024 PWS WILD CHUM SALMON FORECAST SUMMARY

The 2024 PWS wild chum salmon total run forecast point estimate is **Strong at 639,000 fish (80% prediction interval: 401,000–877,000 fish)**. This is 27% above the recent 10-year average (2014–2023) PWS wild chum salmon total run of 503,000 fish. Subtracting the 10-year average escapement, 170,00, from the total run forecast results in a harvest point estimate of **469,000 fish (range: 231,000 to 707,000 fish)**.

FORECAST METHODS

The 2024 PWS wild chum salmon total run forecast uses the 2-year running average method. Several models were examined for the 2024 PWS wild chum total run forecast including exponential smoothing and 2-, 3-, and 5-year running averages of past total runs (Table 5). For 2024, 2-year running average outperformed the other models by having the lowest MAPE, mean absolute squared error (MASE) and median symmetrical accuracy. The 80% prediction intervals were calculated from the mean squared error of the retrospective forecast predictions.

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. The stream escapement index is calculated as the area under the curve of weekly aerial escapement surveys adjusted for estimates of stream life. Hatchery and wild stock contributions were estimated using pre-hatchery average natural runs (1998–2003) or thermally marked otolith estimates (2004–2023) for each district in PWS.

Prince William Sound chum salmon

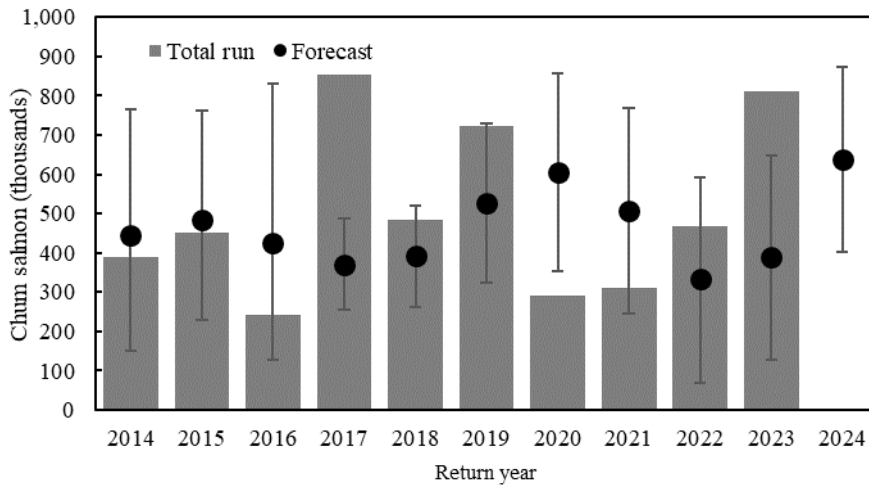


Figure 5. Total run of Prince William Sound wild chum salmon compared to preseason total run forecasts, 2014–2023, and the 2024 forecast. Error bars represent 80% prediction intervals of forecasts.

Table 3. 2024 Copper River Chinook salmon forecast model performance summary. Model selected as the run forecast (lowest MAPE) is shaded.

Stock/model	Prediction Point Estimate	80% Prediction Interval	MAPE
State-space	47,347	33,824–65,944	31%
Exponential	53,053	37,004–69,103	36%
2-year	56,741	31,701–81,781	38%
3-year	47,856	23,097–72,615	40%
5-year	48,135	27,109–69,161	33%

Table 4. 2024 Prince William Sound wild sockeye salmon forecast model summary. Models selected for inclusion in the run forecast (lowest MAPE) are shaded.

Stock/Age Class	Brood Year	Model	Prediction	MAPE
Copper River wild sockeye				
0.3	2020	5-year mean	72,416	
1.1	2021	5-year mean	3,448	
1.2	2020	log 1.2 R/S x BYE	220,596	65%
		log 1.2 x log 1.1	309,838	57%
1.3	2019	1.3 x BYE	1,239,972	49%
		log 1.3R/S x BYE	1,048,799	41%
		log 1.3 x log 1.2	1,396,299	32%
		log 1.3 x log 0.3	1,034,199	43%
		1.3 x 1.2	1,549,482	48%
2.2	2019	log 2.2 x BYE	31,237	69%
		log 2.2 x log 1.2	36,903	64%
2.3	2018	log 2.3 x log 2.2	146,320	61%
		log 2.3 x log 1.3	104,265	70%
Total			1,965,225	

Coghill Lake sockeye			10-year mean	7,390	
1.1	2021				
1.2	2020		log 1.2 R/S x BYE	32,603	179%
			log 1.2 x log 1.1	109,336	131%
1.3	2019		log R/S 1.3 x BYE	77,399	194%
			log 1.3 x log 1.2	137,933	75%
2.2	2019		10-year mean	9,936	
2.3	2018		10-year mean	8,472	
Total				273,067	

Note: R/S = Return per spawner; BYE = Brood year escapement

Table 5. 2024 Prince William Sound wild pink and chum salmon forecast model performance summary. Models selected as the run forecast (lowest MAPE) are shaded.

Run		Prediction	MAPE
PWS wild pink			
	Exponential	6,572,594	5%
	2-year	6,679,267	4%
	3-year	6,446,846	4%
	5-year	4,693,849	4%
PWS wild chum			
	Exponential	452,778	37%
	2-year	639,038	31%
	3-year	529,972	35%
	5-year	520,984	36%