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Advisory Announcement

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2024 Upper Cook Inlet Sockeye Salmon Forecast

The Upper Cook Inlet sockeye salmon total run forecast of **5.72 million fish** (Table 1) is predicted to be **average**. The categorical ranges of sockeye salmon total run strength were developed from the 20th, 40th, 60th, and 80th percentiles of historical runs (Table 2). Forecasts of salmon fisheries are inherently uncertain and are primarily used to gauge the general magnitude of expected runs and guide early-season management strategies.

Table 1.–Forecast of the 2024 Upper Cook Inlet sockeye salmon run, escapement, and harvest in millions of fish. Forecast range is indicated in parenthesis.

Production component	Forecast estimate
Total run	5.72 (4.21–7.22)
Escapement	2.00
Available harvest	3.72

Table 2. – Categorical ranges of Upper Cook Inlet sockeye salmon runs and this year's forecast in bold.

Category	Range (million)	Percentile
Poor	Less than 2.0	Less than 20th
Weak	2.0 to 4.0	20th to 40th
Average	**4.0 to 6.0**	**40th to 60th**
Strong	6.0 to 8.0	60th to 80th
Excellent	Greater than 8.0	Greater than 80th

Forecast Methods

The major sockeye salmon systems in Upper Cook Inlet (UCI) are the Kenai, Kasilof, and Susitna Rivers, and Fish Creek. Five models were evaluated to forecast the total run of sockeye salmon to the Kenai and Kasilof Rivers in 2024: (1) brood-year spawners, (2) emigrating smolt, (3) fall fry, (4) sibling returns and (5) average returns (Table 3). Forecast model performance was assessed using the mean arctangent absolute percent error (MAAPE) between the forecasts and actual runs over the past 10 years (2014–2023; Table 4). The top three models with the lowest MAAPE and statistically significant parameters were selected for each age class and a weighted hybrid model

approach was applied (Table 3). Model weights were assigned based on the MAAPE of each selected model, with a lower MAAPE receiving a greater weight towards the forecast estimate. Weighted forecast estimates were summed across age classes for stock specific run estimates.

For Susitna River sockeye salmon, returns of age-0.3, -1.2, -1.3, -2.2 and -2.3 fish in 2024 were forecasted using mean return per spawner by age class for brood years 2013–2019 Mark–recapture estimates of inriver run and genetic estimates of commercial harvest were available for these brood years.

The 2024 forecast for Fish Creek sockeye salmon was estimated using the recent 5-year (2018-2023) average of total runs to the system. Total run estimates for Fish Creek sockeye salmon in 2021 and 2022 are assumed to be biased low because weir operations were stopped early, and escapement estimates for these years were not expanded to account for unmonitored passage. Additionally, total run estimates for Fish Creek sockeye salmon do not account for personal use harvest.

The sockeye salmon forecast for unmonitored systems in UCI was estimated as 17% of the aggregate forecast for the four monitored stocks. Unmonitored stocks include Crescent River, Big River, McArthur River, Chilligan River, Coal Creek, Cottonwood Creek, Wasilla Creek, Eagle River, Packers Creek, and many other smaller systems in the area. The fraction of the total run destined for unmonitored systems was calculated using genetic estimates of the stock composition of offshore test fishery harvests.

The estimated available harvestable surplus of sockeye salmon was calculated by subtracting the aggregate escapement from the total run forecast for all stocks. Aggregate escapement was estimated as the sum of the midpoints of the escapement goal ranges for each of the monitored sockeye salmon-producing systems and the escapement into unmonitored systems.

Table 3. – Description of models used to forecast returns of sockeye salmon to the Kasilof and Kenai Rivers, 2024.

Model	Description
5-year moving average	Unweighted average of the previous 5-year's returns r for the specified age class.
Exponential smoothing	An exponential function used to assign exponentially decreasing weights over time for the specified age class.
Standard Ricker	Regression between the ratio of recruits of the specified age class and spawners from the same brood year and the number of spawners from the same brood year.
Sibling	Regression between the returns of a specified age class and the most recent returns from the same brood year.
Fry	Regression between the returns of a specified age class and the aggregate total abundance of sockeye salmon fry in Kenai and Skilak Lakes from the same brood year.
Fry CFSWT	Regression between the returns of a specified age class and the aggregate total abundance of age-0 sockeye salmon fry and their average total weight in Kenai and Skilak Lakes from the same brood year.
S AR1	Autoregressive integrated moving average (ARIMA) analysis on the returns of the specified age class with a covariate for the abundance of spawners from the same brood year.
Smolt	Regression between the returns of a specified age class and the abundance of smolt from the same brood year.
Smolt AR1	Autoregressive integrated moving average (ARIMA) analysis on the returns of the specified age class with a covariate for the abundance of smolt from the same brood year.

Note: Log transformation may be needed to meet assumptions of a linear regression.

2023 Run and Forecast

Overall, the 2023 UCI sockeye salmon run of 6.45 million was 1.33 million greater (20%) than the forecast of 5.12 million fish. In 2023, the estimated total run was 3.69 million to the Kenai River; 1.29 million to the Kasilof River; 444,000 to the Susitna River; and 76,000 to Fish Creek. Escapement of Susitna River sockeye salmon in 2023 was estimated by subtracting the projected commercial harvest (average harvest rate of 42% from 2007−2015) from the 2023 run forecast of 340,00 fish. The 2023 run forecast was 2.82 million to the Kenai River; 1.12 million to the Kasilof River; and 90,000 to Fish Creek. In 2023, the commercial harvest of UCI sockeye salmon was 1.57 million fish.

2024 Forecast Results and Discussion

In 2024, a run of approximately 5.72 million sockeye salmon is forecast to return to UCI with an estimate of 3.72 million available for harvest (Table 1). Based on the absolute percentage error (APE) for the recent 10-year (2014–2023) forecasted UCI runs compared with the estimated runs, there is an 80% probability that the 2024 UCI forecast range falls between 4.21 million and 7.22 million fish (Table 1). This UCI forecast is average compared to historical total run estimates from 1986 to present. The UCI forecast has overestimated the total run by an average of 4% over the past 10 years with a range of -27% to 45% (Figure 1).

The Kenai River sockeye salmon forecast is approximately 3.38 million fish (Table 4). The 2024 Kenai River forecast is 500,000 (14%) fish less than the historical (1986–2023) average run of 3.88 million, but 215,000 (6%) fish more than the recent 10-year (2014–2023) average run of 3.17 million (Figure 1). The Kenai River forecast has overestimated the total run by an average of 0.8% over the past 10 years with a range of -42% to 59%.

The Kasilof River sockeye salmon run forecast is approximately 1.12 million fish (Table 4). The Kasilof River forecast has overestimated the total run by an average of 7% over the past 10 years with a range of -35% to 79%. The 2024 forecast is 201,000 fish (20%) greater than the historical (1986–2023) average run of 0.91 million fish and 174,000 fish (17%) greater than the recent 10-year (2014–2023) average run.

Approximately 303,400 and 86,690 sockeye salmon are forecast to return to the Susitna River and Fish Creek respectively in 2024. The 2024 Susitna River sockeye salmon forecast is 127,400 fish (35%) below the historical (2002–2023) average run and 71,600 fish (21%) below the recent 10-year (2014–2023) average run. The 2024 Fish Creek sockeye salmon forecast is 25,450 fish (26%) below the historical average but the same as the recent 10-year average run size (0.26% difference).

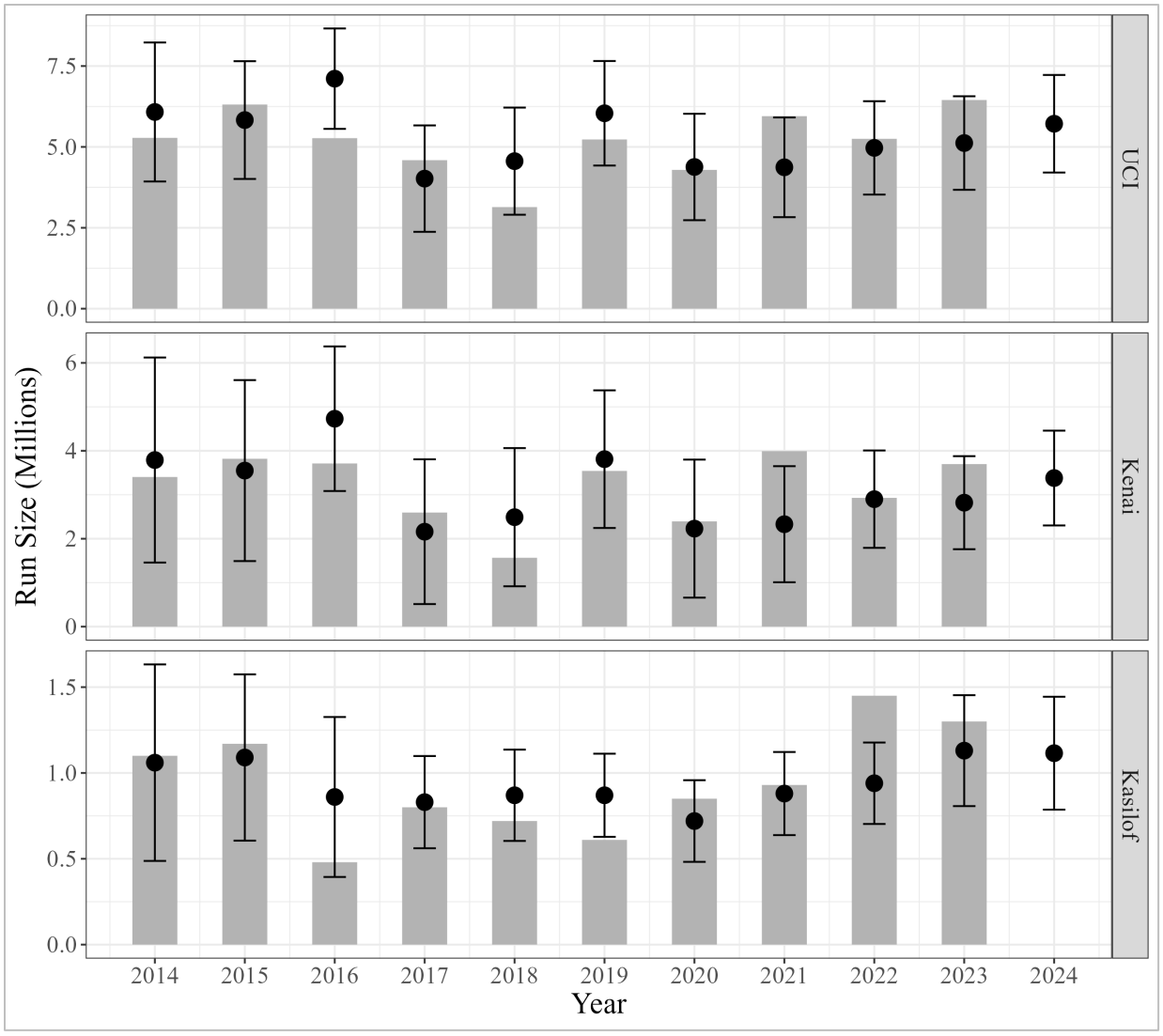

Figure 1.– Actual observed total run (grey bars) of Upper Cook Inlet (top panel), Kenai River (middle panel), and Kasilof River (bottom panel) sockeye salmon compared to total run forecasts (black points), 2014–2023 and 2024 forecast. Error bars represent 80% confidence intervals of forecasts.

Table 4.– Kenai and Kasilof River sockeye salmon forecast estimates, 2024.

River	Age class	Model	MAAPE	Weight	Prediction	Weighted prediction	Subtotal	Total
Kenai	1.2	5-Year moving Average	45.16	0.35	578,135	204,746		
		Exponential Smoothing	49.15	0.33	555,666	180,795		
		Standard Ricker	49.90	0.32	404,720	129,706	515,248	
	1.3	Log Sibling	17.32	0.46	1,854,690	845,398		
		Log Fry CFSWT	27.74	0.28	3,052,480	868,783		
		Exponential Smoothing	30.42	0.26	1,655,623	429,747	2,143,928	
	2.2	Log S AR1	20.26	0.40	202,188	80,143		
		Log Sibling	24.58	0.33	260,087	84,992		
		Log Sibling AR1	29.01	0.28	302,218	83,665	248,800	
	2.3	Fry	39.51	0.38	394,046	150,045		
		Exponential Smoothing	42.35	0.36	636,693	226,163		
		5-Year Moving Average	56.98	0.26	364,675	96,276	472,484	**3,380,460**
Kasilof	1.2	Log S AR1	38.15	0.34	350,832	120,648		
		Exponential Smoothing	38.33	0.34	629,000	215,311		
		5-Year Moving Average	41.81	0.31	541,872	170,041	506,000	
	1.3	Log Sibling	32.07	0.41	355,305	146,107		
		Log Smolt	44.51	0.30	253,616	75,147		
		Exponential Smoothing	45.09	0.29	379,387	110,964	332,218	
	2.2	Log Sibling	31.23	0.42	238,446	99,154		
		Log S AR1	42.81	0.30	198,464	60,197		
		Sibling AR1	46.24	0.28	222,799	62,573	221,924	
	2.3	Log Smolt AR1	53.71	0.34	63,541	21,916		
		Sibling	54.39	0.34	73,073	24,886		
		Exponential Smoothing	58.90	0.31	26,126	8,217	55,019	**1,115,161**

OTHER SALMON SPECIES

Table 5.–Recent average commercial harvest for other salmon species in Upper Cook Inlet, 2024.

Species	5-year average
pink salmon	319,500
chum salmon	91,000
coho salmon	127,400

Recent Run Discussion

Due to the lack of information, the department does not formally forecast these species. The recent 5-year average commercial harvests are presented for chum and coho salmon (Table 5). Pink salmon commercial harvest average is based upon the previous 5 even-numbered years (Table 5). Harvests in these years represent current management strategies. In 2024, harvest opportunities will be based on inseason information.

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