



## Advisory Announcement

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## 2022 Upper Cook Inlet Sockeye Salmon Forecast

The forecasts of the 2022 Upper Cook Inlet sockeye salmon run and harvests are as follows:

	Forecast Estimate (millions)	Forecast Range (millions)
<b>TOTAL PRODUCTION:</b>		
Total Run	4.97	3.30–10.11
Escapement	2.00	
Harvest	2.97	

### Forecast Methods

The major sockeye salmon systems in Upper Cook Inlet (UCI) are the Kenai, Kasilof, and Susitna rivers, and Fish Creek. Available escapement (spawner abundance), return, sibling, fry, and smolt data were examined for each system. Four model types were evaluated to forecast the total run of sockeye salmon to UCI in 2022: (1) brood-year spawners, (2) fall fry, (3) emigrating smolt, and (4) sibling returns. These forecast models were evaluated for the Kenai, Kasilof, and Susitna Rivers and Fish Creek stocks and age classes. Models that provided the smallest mean absolute percentage error (MAPE) between the forecasts and actual runs over the past 10 years were selected for the 2022 forecast (Table 1).

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, and many other smaller systems in the area. The fraction of the total run destined for unmonitored systems was estimated using genetic estimates of the stock composition of offshore test fishery harvests.

The estimated total harvest of sockeye salmon by all user groups 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 (Table 2) and the escapement into unmonitored systems.

## **2021 Run and Forecast**

Overall, the 2021 UCI sockeye salmon run of 5.95 million was 1.58 million greater (36%) than the preseason forecast of 4.37 million fish. In 2021, the estimated total run was 3.83 million to the Kenai River; 861,000 to the Kasilof River; 424,000 to the Susitna River; and 122,000 to Fish Creek. The 2021 run forecast was 2.33 million to the Kenai River; 881,000 to the Kasilof River; 436,000 to the Susitna River; and 92,000 to Fish Creek. In 2021, the commercial harvest of 1.41 million sockeye salmon in UCI was 0.23 million less (14%) than the preseason forecast of 1.64 million.

## **2022 Forecast Discussion**

In 2022, a run of approximately 4.97 million sockeye salmon is forecast to return to UCI with an estimate of 2.97 million available for harvest (commercial, sport, personal use, subsistence). Based on the absolute percentage error (APE) for the historical forecasted UCI runs compared with the estimated runs, there is an 80% probability that the 2022 UCI forecast range falls between 3.30 million and 10.11 million fish. This UCI forecast is weak based on historical total run estimates from 1986 to present (Table 3). The UCI preseason forecast has overestimated the total run by an average of 5% over the past 5 years with a range of -45% to 27% (Table 4).

The Kenai River forecast of 2.90 million sockeye salmon is 794,000 less (21%) than the 20-year average run of 3.70 million, but 19,000 less than the 5-year average of 2.92 million (Table 2). The Kenai run forecast is weak based on historical total run estimates from 1986 to present (Table 3). The Kenai preseason forecast has underestimated the total run by an average of 4% over the past 5 years with a range of -50% to 39% (Table 4). The predominant age classes in the 2022 run forecast are age-1.2 (12%) and age-1.3 (71%). For the age-1.2 forecast, a spawner-recruit/brood interaction model forecast a return of 342,000 sockeye salmon in 2022 (Table 1 and Table 2). The age-1.2 forecast is 65,000 (16%) and 40,000 (10%) less than the 20-year and 5-year averages, respectively (Table 2). A fry model based upon age-0 juvenile sockeye salmon that resided in Kenai and Skilak Lakes predicts a return of 2.06 million age-1.3 salmon in 2022 (Table 1 and Table 2). The age-1.3 forecast return is 178,000 less (8%) than the 20-year average and 128,000 more (7%) than the 5-year average (Table 2). It is notable for the age 1.3 forecast that the log sibling model forecasts a return of approximately 171,000 more fish than the chosen fry model, but it had slightly larger 5-year and 10-year MAPEs (Table 1).

The Kasilof River sockeye salmon run forecast is approximately 941,000 fish (Table 2). The Kasilof preseason forecast is considered average based on historical total run estimates from 1986 to present (Table 3). The Kasilof preseason forecast has overestimated the total run by an average of 10% over the past 5 years with a range of -31% to 10% (Table 4). The 2022 forecast is 51,000 less (5%) than the 20-year average but is 168,000 greater (22%) than the 5-year average (Table 2). The predominant age classes in the 2022 run forecast are age-1.2 (33%), age-1.3 (43%), and age-2.2 (21%). A spawner-recruit model based on the spawning population in 2018 forecast a return of 312,000 age-1.2 salmon in 2022 (Table 1 and Table 2). The age-1.2 forecast is 44,000 less (12%) than the 20-year average return and is 90,000 less (22%) than the 5-year average return. A sibling model based upon the return of age-1.2 salmon in 2021 (548,000; 356,000 20-year average) was used to forecast a return of 407,000 age-1.3 salmon in 2022 (Table 1 and Table 2). The 2022 age-1.3 forecast return is 107,000 greater (36%) than the 20-year average and 216,000 greater (113%) than the 5-year average returns. A sibling model based upon the return of age-2.1 salmon in 2021 was used to forecast a return of 193,000 age-2.2 salmon in 2022. The 2022 age-2.2

forecast is 49,000 less (20%) less than the 20-year average and 58,000 greater (43%) than the 5-year average (Table 2).

The Susitna River sockeye salmon run forecast is 310,000 fish, which is 55,000 fish less (15%) than the 10-year average of 365,000 (Table 2). This forecast was derived using mean return per spawner by age class and mark–recapture estimates of spawner abundance for brood years 2006–2018. Sonar estimates of spawner abundance were not used, because mark–recapture studies have shown that the Yentna River sonar project underestimated sockeye salmon escapement causing estimates of adult returns to also be underestimated. The predominant age classes in the 2022 Susitna sockeye salmon run forecast are estimated to be age-1.2 (25%) and age-1.3 (50%).

The Fish Creek sockeye salmon run forecast for 2022 is 89,000 fish. This forecast is approximately 3,000 fish greater (3%) than the 20-year average run of 86,000 (Table 2). Sibling models based upon the returns of age-1.1, -1.2, -2.1, and -2.2 salmon in 2021 was used to forecast the 2022 returns. The predominant age classes in the 2022 Fish Creek run forecast are estimated to be age-1.2 (57%) and age-1.3 (27%). The 10-year MAPE for the Fish Creek sockeye salmon run forecast is 76%.

Table 1.–2022 UCI forecast model, prediction, 10-year MAPE, 5-year MAPE. Boxes indicate values chosen for 2022 preseason forecast.

River	Age class	Model	Prediction	10-year MAPE	5-year MAPE
Kenai	1.2	Log R vs Log S	321,899	0.425	0.460
		Standard Ricker	355,107	0.413	0.463
		Brood Interaction Model	342,131	0.380	0.390
	1.3	Log R vs Log Fry	1,801,816	0.394	0.599
		Log R = Log Fry CFSWT	2,059,339	0.248	0.323
		Log Sibling	2,230,375	0.251	0.320
	2.2	Log R vs Log S	206,658	0.950	1.476
		Log Sibling	213,030	0.804	0.837
		Log Sibling AR1	183,299	0.530	0.690
		5-year average	119,950	0.861	0.918
	2.3	Sibling omit4	370,213	1.337	2.227
		Sibling	541,003	2.007	3.616
		Log Sibling	303,411	0.991	1.507
		Log Sibling omit4	260,661	0.868	1.246
		Fall Fry age-1 Smolt age-2	809,825	1.792	3.197
Kasilof	1.2	Log R vs Log S	311,609	0.326	0.277
		Log R vs Log S AR1	411,673	0.343	0.332
		Log Sibling	262,737	0.347	0.372
		Log Smolt	288,905	0.387	0.494
		Log Smolt AR2	493,734	0.472	0.298
	1.3	Log Sibling	407,203	0.650	0.825
		Log Sibling AR1	500,717	0.844	1.212
	2.2	Log R vs Log S	231,938	1.034	1.890
		Log R vs Log S AR1	91,311	0.504	0.830
		Sibling AR2	108,850	0.463	0.740
		Log Sibling	193,087	0.398	0.652
		Log Sibling AR1	70,928	0.399	0.541
	2.3	Sibling	38,030	5.061	9.096
		Sibling AR2	8,998	1.573	2.464
		Log Sibling	19,602	4.703	8.272
Log Smolt		63,511	3.3444	6.127	

Table 2.—2022 Sockeye salmon run forecasts, 20-year (10-year Susitna River) and 5-year average runs, and escapement goals (in thousands of fish) to individual freshwater systems in Upper Cook Inlet.

System		Major age classes				Total run <sup>a</sup>	Escapement goals <sup>b</sup>
		1.2	1.3	2.2	2.3		
<b>Kenai River</b>	<b>Forecast</b>	<b>342</b>	<b>2,059</b>	<b>183</b>	<b>261</b>	<b>2,902</b>	<b>1,100 – 1,400<sup>c</sup></b>
	20-yr average	407	2,237	225	756	3,696	
	5-yr average	382	1,931	120	431	2,921	
<b>Kasilof River</b>	<b>Forecast</b>	<b>312</b>	<b>407</b>	<b>193</b>	<b>9</b>	<b>941</b>	<b>140 – 320</b>
	20-yr average	356	300	242	72	992	
	5-yr average	402	191	135	29	773	
<b>Susitna River</b>	<b>Forecast</b>	<b>77</b>	<b>156</b>	<b>21</b>	<b>37</b>	<b>310</b>	<b>Lakes Goals<sup>d</sup></b>
	10-yr average	114	171	25	33	365	
	5-yr average	122	143	22	29	319	
<b>Fish Creek</b>	<b>Forecast</b>	<b>51</b>	<b>24</b>	<b>7</b>	<b>2</b>	<b>89</b>	<b>15 – 45</b>
	20-yr average	55	18	6	2	86	
	5-yr average	73	8	6	0.5	94	
<b>Unmonitored</b>	<b>Forecast</b>	<b>134</b>	<b>453</b>	<b>69</b>	<b>53</b>	<b>725</b>	<b>No Goal</b>
	20-yr average	159	466	85	148	879	
	5-yr average	167	389	48	84	702	
<b>Total Run</b>	<b>Forecast</b>	<b>916</b>	<b>3,099</b>	<b>473</b>	<b>361</b>	<b>4,967</b>	
	20-yr average	1,091	3,192	584	1,011	6,019	
	5-yr average	1,146	2,662	332	572	4,808	

<sup>a</sup> Total run includes all age classes.

<sup>b</sup> Specific goal types are as follows: Kenai River: inriver; Kasilof River: biological escapement goal (BEG); Susitna River (3 weir goals) and Fish Creek: sustainable escapement goal (SEG).

<sup>c</sup> Inriver goal for sockeye salmon runs greater than 2.3 million measured using sonar at river mile 19 on the Kenai River.

<sup>d</sup> Susitna sockeye salmon are managed to achieve escapement goals at Larson, Chelatna and Judd lakes weirs. Current escapement goals for these lakes are Larson 15,000–35,000, Chelatna 20,000–45,000 and Judd 15,000–40,000. Chelatna Lake weir will not be operated in 2022.

Table 3.–Percentile range of Upper Cook Inlet estimated total runs from 1986 to 2021. Boxed in values indicate 2022 preseason forecast strength.

UCI category	UCI Range (millions)	Kenai Range (millions)	Kasilof Range (millions)	Percentile
Poor	< 3.90	< 2.30	< 0.68	< 20 <sup>th</sup>
Weak	3.90–5.00	2.30–3.10	0.68–0.80	20 <sup>th</sup> to 40 <sup>th</sup>
Average	5.00–5.77	3.10–3.63	0.80–0.95	40 <sup>th</sup> to 60 <sup>th</sup>
Strong	5.77–7.50	3.63–5.00	0.95–1.15	60 <sup>th</sup> to 80 <sup>th</sup>
Excellent	> 7.50	> 5.00	> 1.15	> 80 <sup>th</sup>

Table 4.–Comparison of % error of UCI sockeye salmon forecasts vs estimated runs (millions) for UCI and Kenai and Kasilof river stocks (2017-2021).

Year	UCI			Kenai			Kasilof		
	Forecast	Total run estimate	% Error	Forecast	Total run estimate	% Error	Forecast	Total run estimate	% Error
2017	4.02	4.59	13.	2.16	2.89	25	0.83	0.82	-1
2018	4.56	3.14	-45	2.49	1.66	-50	0.87	0.70	-24
2019	6.04	5.23	-15	3.81	3.63	-5	0.87	0.67	-31
2020	4.38	4.29	-2	2.23	2.55	13	0.72	0.80	10
2021	4.37	5.95	27	2.33	3.83	39	0.88	0.86	-2
Min	4.02	3.14	-45	2.16	1.66	-50	0.72	0.67	-31
Average	4.67	4.64	-5	2.60	2.91	4	0.83	0.77	-10
Max	6.04	5.95	27	3.81	3.83	39	0.88	0.86	10

## OTHER SALMON SPECIES

The forecast of the 2022 Upper Cook Inlet commercial harvest of other salmon species is as follows:

Commercial harvest forecasts	
Pink salmon	391,000
Chum salmon	117,000
Coho salmon	191,000
Chinook salmon	4,179

### Forecast Methods

The recent 5-year average commercial harvest was used to forecast the harvest of chum, coho, and Chinook salmon in 2022. The forecast for pink salmon is based upon the average harvest during the previous 5 even-numbered years.

### Forecast Discussion

The recent 5-year average commercial harvest was used in the forecast, because harvests in these years likely best represent harvests under current regulations.

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