



Advisory Announcement

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CONTACT: Bob DeCino
Area Research Biologist
(907) 262-9368

2021 Upper Cook Inlet Sockeye Salmon Forecast

The forecasts of the 2021 Upper Cook Inlet sockeye salmon run and harvests are as follows:

	Forecast Estimate (millions)	Forecast Range (millions)
TOTAL PRODUCTION:		
Total Run	4.37	2.89–8.99
Escapement	2.00	
Harvest	2.37	

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 2021: (1) the relationship between adult returns and spawners, (2) the relationship between adult returns and fall fry, (3) the relationship between adult returns and emigrating smolt, and (4) the relationship between sibling returns. Several forecast models were evaluated for each stock and age class. 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 2021 forecast; however, the 5-year MAPE was used for model selection in cases where the 10-year MAPE values were nearly identical.

For Kenai River sockeye salmon, the return of age-1.3 fish in 2021 was forecasted using a sibling model. The sibling model prediction of the return of age-1.3 salmon was based on the abundance estimate of age-1.2 sockeye salmon that returned to the Kenai River in 2020. A spawner-recruit model was used to predict the age-1.2 salmon return based upon the spawning escapement in 2017. The Kenai River return of age-2.2 salmon was forecasted using a sibling model based upon the abundance of age-2.1 salmon that returned in 2020, and the return of age-2.3 salmon was forecasted using a sibling model based upon the abundance of age-2.2 salmon that returned in 2020.

For Kasilof River sockeye salmon, returns of age-1.3, -2.2, and -2.3 fish in 2021 were all forecasted using sibling models based upon returns of age-1.2, -2.1, and -2.2 salmon in 2020. The return of age-1.2 sockeye salmon was forecasted using a smolt model of age-1 smolt emigrating in spring 2017.

For Susitna River sockeye salmon, returns of age-0.3, -1.2, -1.3, -2.2 and -2.3 fish in 2021 were forecasted using mean return per spawner by age class for brood years 2006–2017. Mark–recapture estimates of inriver run and genetic estimates of commercial harvest were available for these brood years.

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 1) and the escapement into unmonitored systems, which was estimated as 17% of the escapement to the monitored systems..

The 2021 total UCI run forecast point estimate is 4.37 million sockeye salmon. Based on the absolute percentage error (APE) for the historical forecasted UCI runs compared with the actual runs, there is an 80% probability that the 2021 UCI forecast range falls between 2.89 million and 8.99 million fish.

2020 Run and Forecast

Overall, the 2020 sockeye salmon run (4.36 million) was 2% above forecast (4.27 million). In 2020, the estimated total run was 2.55 million to the Kenai River; 821,000 to the Kasilof River; 380,000 to the Susitna River; and 74,000 to Fish Creek. The 2020 run forecast was 2.23 million to the Kenai River; 723,000 to the Kasilof River; 571,000 to the Susitna River; and 121,000 to Fish Creek. In 2020, the commercial harvest of 0.70 million sockeye salmon in UCI was 1.15 million less than the preseason forecast of 1.85 million.

2021 Forecast Discussion

In 2021, a run of approximately 4.37 million sockeye salmon is forecasted to return to UCI with an estimate of 2.37 million available for harvest (commercial, sport, personal use, subsistence).

The run forecast for the Kenai River is approximately 2.33 million sockeye salmon, which is 1.29 million less (36%) than the 20-year average run of 3.61 million, but only 500,000 less than the 5-year average (Table 1). For the age-1.2 forecast, a spawner-recruit model forecast a return of 367,000 sockeye salmon in 2021 (Table 1 and Table 2). The age-1.2 forecast lies between the 20-year and 5-year averages, respectively (Table 1). A sibling model based upon the return of age-1.2 salmon predicts a return of 1.67 million age-1.3 salmon in 2021 (Table 1 and Table 2). The age-1.3 forecast return is 24% less than the 20-year average and 9% less than the 5-year average (Table 1). A sibling model based on the return of age-2.1 fish in 2020 forecast a return of 120,000 age-2.2 fish for 2021 (Table 1 and Table 2). The age-2.2 return forecast is 47% less than the 20-year average but is about 2% greater than the 5-year average return (Table 1). A sibling model based upon the return of age-2.2 salmon in 2020 (74,000 vs 20-year average of 225,000) predicts a return of 122,000 age-2.3 fish (Table 1). The age-2.3 return forecast is substantially less than the 20-year and 5-year average returns at 83% and 77%, respectively (Table 1). The predominant age classes

in the 2021 run forecast are age-1.2 (16%) and age-1.3 (72%). The 10-year MAPE for the set of models used for the 2021 Kenai sockeye salmon run forecast is 17%.

The Kasilof River sockeye salmon run forecast is 881,000 fish. The 2021 forecast is 105,000 less (12%) than the 20-year average but is 168,000 greater (24%) than the 5-year average (Table 1). A smolt model based on the emigration of age-1 smolt in 2018 forecast a return 383,000 age-1.2 salmon in 2021 (Table 1 and Table 2). The age-1.2 forecast is 13% larger than the 20-year average return and is 18% greater than the 5-year average return. A sibling model based upon the return of age-1.2 salmon in 2020 (493,000; 340,000 20-year average) was used to forecast a return of 390,000 age-1.3 salmon in 2021 (Table 1 and Table 2). The 2021 age-1.3 forecast return is 27% and 125% greater than the 20-year and 5-year average returns. A sibling model based upon the return of age-2.1 salmon in 2020 was used to forecast a return of 73,000 age-2.2 salmon in 2021. The 2021 age-2.2 forecast is 70% less than the 20-year average (Table 1) and 56% less than the 5-year average (Table 1). The predominant age classes in the 2021 run forecast are age-1.2 (44%), age-1.3 (44%), and age-2.2 (8%). The 10-year MAPE for the set of models used for the 2021 Kasilof sockeye salmon run forecast is 22%.

The Susitna River sockeye salmon run forecast is 436,000 fish, which is 59,000 greater (16%) than the 10-year average of 377,000 (Table 1). This forecast was derived using mean return per spawner by age class and mark–recapture estimates of spawner abundance for brood years 2006–2016. 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 5-year MAPE for this forecast method is 26%. The predominant age classes in the 2021 Susitna sockeye salmon run forecast are estimated to be age-1.2 (21%) and age-1.3 (53%).

The Fish Creek sockeye salmon run forecast for 2021 is 92,000 fish. This forecast is approximately 6,000 fish greater (7%) than the 20-year average run of 86,000 (Table 1). Sibling models based upon the returns of age-1.1, -1.2, -2.1, and -2.2 salmon in 2020 was used to forecast the 2021 returns. The predominant age classes in the 2021 Fish Creek run forecast are estimated to be age-1.2 (67%) and age-1.3 (18%). The 10-year MAPE for the Fish Creek sockeye salmon run forecast is 79%.

Table 1.—2021 Sockeye salmon run forecasts, 20-year 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 ^a	Escapement goals ^b
		1.2	1.3	2.2	2.3		
Kenai River	Forecast	367	1,670	120	122	2,325	1,100 – 1,400^c
	20-yr average	396	2,184	225	738	3,615	
	5-yr average	328	1,828	118	527	2,854	
Kasilof River	Forecast	383	390	73	17	881	140 – 320
	20-yr average	340	307	246	73	986	
	5-yr average	324	173	167	33	713	
Susitna River	Forecast	91	233	31	44	436	Lakes Goals^d
	10-yr average	103	186	25	30	377	
	5-yr average	107	155	24	24	322	
Fish Creek	Forecast	62	17	6	1	92	15 – 45
	20-yr average	51	19	6	2	86	
	5-yr average	61	22	4	1	91	
Unmonitored	Forecast	154	395	39	31	639	No Goal
	20-yr average	152	461	86	144	866	
	5-yr average	139	368	53	99	677	
Total Run	Forecast	1,057	2,705	269	216	4,373	
	20-yr average	1,043	3,157	589	987	5,929	
	5-yr average	959	2,534	366	684	4,657	

^a Total run includes all age classes.

^b 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).

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

^d 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 may not be operated in 2021.

Table 2.—2021 UCI forecast model, prediction, 10-year MAPE, 5-year MAPE, *P*-value and adjusted R-square. Boxed values chosen for 2021 preseason forecast.

River	Age class	Model	Prediction	10-year MAPE	5-year MAPE	<i>P</i> -value	Adj R-square
Kenai	1.2	Log R vs Log S	358,319	0.441	0.573	<.0001	0.2911
		Standard Ricker	370,382	0.426	0.576	<.0001	0.2727
		Brood Interaction Model	366,582	0.416	0.482	0.0001	0.2574
	1.3	Log R vs Log Fry	2,064,295	0.472	0.599	0.0124	0.1693
		Log R = Log Fry CFSWT	2,526,074	0.279	0.332	0.0001	0.4680
		Log Sibling	1,670,361	0.278	0.285	<.0001	0.5478
	2.2	Log R vs Log S	211,015	0.925	1.586	0.0367	0.0717
		Log Sibling	194,809	0.804	1.408	0.0073	0.1392
		Log Sibling AR1	119,890	0.524	0.815	<.0001	NA
		5-year average	115,913	0.892	1.238	NA	NA
	2.3	Sibling omit4	267,229	1.372	1.467	0.0001	0.2878
		Sibling	446,300	2.067	3.648	0.0837	0.0442
		Log Sibling	142,722	1.004	1.473	<.0001	0.3064
		Log Sibling omit4	122,488	0.880	1.219	<.0001	0.4096
		Fall Fry age-1 Smolt age-2	644,924	1.836	3.183	0.0005	0.3254
Kasilof	1.2	Log R vs Log S	289,305	0.496	0.267	0.0002	0.2496
		Log R vs Log S AR1	406,476	0.427	0.332	0.0072	NA
		Log Sibling	244,623	0.449	0.337	0.0116	0.1094
		Log Smolt	268,949	0.370	0.319	0.0106	0.1574
		Log Smolt AR2	382,998	0.299	0.294	0.0024	NA
	1.3	Log Sibling	389,903	0.582	0.808	<.0001	0.4205
		Log Sibling AR1	452,734	0.762	1.124	0.0019	NA
	2.2	Log R vs Log S	162,720	0.812	1.361	<.0001	0.4891
		Log R vs Log S AR1	84,664	0.435	0.651	0.2345	NA
		Sibling AR2	90,712	0.379	0.589	0.0006	NA
		Log Sibling	72,833	0.253	0.383	0.0029	0.1594
		Log Sibling AR1	78,961	0.322	0.459	<.0001	NA
	2.3	Sibling	49,419	4.983	9.162	0.0001	0.2664
		Sibling AR2	16,858	4.216	7.685	0.0322	NA
		Log Sibling	34,559	4.692	8.525	<.0001	0.3977
Log Smolt		68,821	3.243	3.580	0.6668	-0.0252	

OTHER SALMON SPECIES

The forecast of the 2021 Upper Cook Inlet commercial harvest of other salmon species is as follows:

Commercial harvest forecasts	
Pink salmon	74,000
Chum salmon	127,000
Coho salmon	191,000
Chinook salmon	5,390

Forecast Methods

The recent 5-year average commercial harvest was used to forecast the harvest of chum, coho, and Chinook salmon in 2021. The forecast for pink salmon is based upon the average harvest during the previous 5 odd-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.

For more information contact Bob DeCino or Brian Marston at the Soldotna ADF&G office at (907) 262-9368.