2011 Westward Region Salmon Forecast

Alaska Department of Fish and Game

Division of Commercial Fisheries

211 Mission Road

Kodiak, Alaska 99615

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Table 1.–Actual versus projected 2010 commercial salmon harvest by species and fishery, and 2011 harvest projections for the Kodiak Management Area.

	Chinook	Sockeye	Coho	Pink	Chum	Total
Projected Harvest 2010 [a]	20,000	2,491,584	413,108	11,400,000	1,016,668	15,341,360
Actual Harvest 2010 [a]	14,550	1,436,606	266,431	8,864,796	734,806	11,317,189
Projected Harvest 2011	20,000	2,053,228	373,048	29,300,000	1,139,578	32,885,854

	2010 Harvest		2011 Harvest
FISHERY	Projection [b]	Actual [c]	Projection [b]
Early Sockeye Salmon Fisheries (6/1-7/15)			
Kitoi Bay Hatchery [d]	30,646	63,833	46,900
Cape Igvak [e]	109,477	175,955	142,343
Karluk [f]	55,000	107,129	99,926
Ayakulik [g]	294,000	91,916	288,863
Alitak District [h]	176,000	30,691	140,424
Minor Enhancement [i]	30,400	44,840	43,000
Spiridon [j]	88,000	103,587	93,244
Other [k]	309,000	187,066	399,970
Subtotal	1,092,523	805,017	1,254,670
Late Sockeye Salmon Fisheries (7/16-10/31)			
Kitoi Bay Hatchery [d]	40,598	27,291	20,100
Cape Igvak [e]	96,463	29,815	87,036
Karluk [f]	440,000	190,021	139,845
Ayakulik [g]	126,000	177,527	123,799
Alitak District [h]	213,000	85,247	216,400
Spiridon [j]	88,000	70,886	39,962
Other [k]	395,000	50,802	171,416
Subtotal	1,399,061	631,589	798,558
TOTAL SOCKEYE	2,491,584	1,436,606	2,053,228
Pink Salmon Fisheries			
Kitoi Bay Hatchery [d]	5,700,000	3,250,469	7,400,000
Afognak (Wild) [l]	416,100	1,997,971	3,066,000
Westside Kodiak [m]	4,109,700	2,645,798	5,037,000
Alitak [n]	484,500	146,363	4,818,000
Eastside/Northend Kodiak [o]	467,400	682,887	8,103,000
Mainland [p]	222,300	141,308	876,000
Subtotal	11,400,000	8,864,796	29,300,000
Chum Salmon Fisheries			
Kitoi Bay Hatchery [d]	273,668	191,284	411,000
Afognak (Wild) [l]	30,000	37,607	36,446
Westside Kodiak [m]	291,000	175,305	221,945
Alitak [n]	48,000	18,836	52,972
Eastside/Northend Kodiak [o]	220,000	136,434	267,112
Mainland [p]	154,000	175,340	150,102
Subtotal	1,016,668	734,806	1,139,578

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Table 1.–Page 2 of 2.

| FISHERY | 2010 Harvest | | 2011 Harvest |
	Projection [b]	Actual [c]	Projection [b]
Coho Salmon Fisheries			
Kitoi Bay Hatchery [d]	155,108	113,909	156,000
Afognak [l]	42,000	25,949	28,002
Westside Kodiak [m]	136,000	58,138	107,218
Alitak [n]	9,000	14,547	8,945
Eastside/Northend Kodiak [o]	51,000	32,115	52,072
Mainland [p]	20,000	21,773	20,810
Subtotal	413,108	266,431	373,048
GRAND TOTAL [q]	15,341,360	11,317,189	32,885,854

Note: Harvest projections presented in this table represent formal forecasts as well as projections based on past fishery performance.

[a] In number of salmon (rounded to nearest hundred). Does not include subsistence, sport, personal use, or ADF&G test fish harvests.

[b] Projected harvests for enhanced and major sockeye systems are based on the formal forecasts for those individual stocks (total run minus escapement) and the projected harvest from minor sockeye systems and other salmon species are based on less formal escapement to return relationships.

[c] Actual harvest is the number taken in a particular geographic area, not the catch assigned to an individual salmon stock.

[d] From the Duck Bay, Izhut Bay, and Inner and Outer Kitoi Bay sections only.

[e] From the Cape Igvak Section. Early run is from the beginning of season through June 26. Late run is from July 8 through 25.

[f] From the Southwest Afognak Section, Northwest Kodiak District (except for Spiridon and Settler Cove Terminal Harvest Areas), Inner and Outer Karluk sections, plus 50% of Halibut Bay Section from June 21 through July 15 and 100% after July 31.

[g] From the Outer and Inner Ayakulik sections, plus 50% of Halibut Bay Section from June 21 through July 15 and 100% from July 16 through 31.

[h] From the Alitak Bay District. Frazer and Upper Station harvest estimates are based on initial run and fishery timing and stock separation.

[i] From the Foul Bay, Waterfall Bay, and Settler Cove Special Harvest areas.

[j] From the Spiridon Lake Special Harvest Area (Telrod Cove), plus an estimate of Spiridon-bound sockeye taken in adjacent areas.

[k] From minor systems at Inner and Outer Ugak Bay (Saltery), Buskin River, Perenosa Bay (Portage), Northwest Afognak (Thorsheim & Long Lagoon), Big River (Swikshak), and Outer Kukak Bay (Kaflia & Kuliuk) sections.

[l] From the Afognak District except for the Duck, Izhut, and Inner and Outer Kitoi Bay sections.

[m] From the Southwest Kodiak District (256- and 255-) and the Northwest Kodiak District (254- and 253-) except for the North Cape, Anton Larson, Sharatin, and Kizhuyak sections, and part of the Central Section (259-35 to 259-39).

[n] From the Alitak District.

[o] From the Eastside Kodiak District (258-, and 259-40 to 259-42), Northeast Kodiak District (259-21 to 259-25), and the North Cape, Anton Larson, Sharatin, and Kizhuyak sections, plus part of the Central Section (259-35 to 259-39).

[p] From the Mainland District.

[q] Includes the projected 2010 harvest of 20,000 Chinook salmon, the actual 2010 harvest of 14,550 Chinook salmon and a projected 2011 harvest of 20,000 Chinook salmon.

Forecast Area: Kodiak
Species: Pink Salmon

Preliminary Forecast of the 2011 Run

Total Production	Forecast Estimate (millions)	Forecast Range (millions)
KMA Wild Stock Total Run	27.9	21.9–35.6
KMA Escapement Goal [a]	6.0	2.3–6.0
KMA Wild Stock Harvest	21.9	15.9–29.6
Kitoi Bay Hatchery Harvest [b]	7.4	4.9–9.8
Total KMA Pink Salmon Harvest	29.3	20.8–39.3

Note: Column numbers may not total or correspond exactly with numbers in text due to rounding.

[a] The 2011 escapement goal forecast combines Kodiak Archipelago odd-year aggregate (2.0 to 5.0 million) and the Mainland District aggregate (250,000 to 1.0 million), based on escapement goal recommendations for 2011.

[b] This figure is the total expected return (7.7 million) minus the broodstock collection goal of 350,000; the Kitoi Bay Hatchery cost recovery harvest is expected to be roughly 1.0 to 2.0 million.

The 2011 KMA predicted pink salmon harvest is expected to be in the Excellent category with a point estimate of 29.3 million (20.8 to 39.3 million) pink salmon combined from the wild stock and Kitoi Bay Hatchery harvests. Harvest categories were delimited from the 20th, 40th, 60th, and 80th percentiles of historical commercial harvest in the KMA from 1978 to 2010 and will be used to determine the length of initial fishing periods.

Total KMA Harvest Category	Range (millions)	Percentile
Poor	Less than 7.6	Less than 20th
Weak	7.6 to 10.7	21st to 40th
Average	10.7 to 14.4	41st to 60th
Strong	14.4 to 21.8	61st to 80th
Excellent	Greater than 21.8	81st to 100th

Forecast Methods

The KMA wild stock pink salmon harvest forecast is derived from a total run forecast minus the upper end (6.0 million) of the combined aggregate escapement goal ranges for the Kodiak Archipelago and Mainland ADF&G in 2010. Total run estimates were derived from a combination of weir counts on the Karluk and Ayakulik rivers, aerial survey indices, and harvest estimates. For the 2011 KMA wild stock pink salmon forecast, a generalized Ricker model was fit to the odd-year KMA returns from 1979 to 2009, utilizing KMA pink salmon indexed escapement for the spawner index. Four additional terms were included in this generalized Ricker model: (1) Karluk and Ayakulik rivers pink salmon weir counts, (2) average air temperature in March, (3) average precipitation in April and May, and (4) average air temperature in April and May.

The generalized model assumes that these environmental conditions affect survival at early life history stages of pink salmon and were lagged correspondingly. All environmental conditions were estimated from Kodiak Airport climate observations. In constructing and evaluating the regression model, standard regression diagnostic procedures were used. Based on the generalized Ricker model, 80% prediction intervals were estimated.

The 2011 KBH pink salmon forecast was prepared by evaluating pink salmon survivals from even brood years 1991 through 2009, when releases from KBH exceeded 100 million fry. Brood years 1996 through 2009 were particularly important to the forecasting model because all pink fry were released on the same day to saturate the release area with fry (predator satiation), a strategy shown to significantly improve fry to adult survival. The pink salmon return to KBH is odd-year dominant and has had exceptional marine survival every fourth year dating back to the first releases in 1977 (except 1997). The primary forecasting consideration for 2011 is this 4-year cycle, which should be above average in 2011 but weaker than 2009. The midpoint estimate of 7.7 million reflects a marine survival of 5.3%.

Forecast Discussion

The 2011 KMA wild stock pink salmon total run (27.9 million) will be well above average and the highest odd-year total since 1995. Confidence in the 2011 forecast estimate is fair based on the regression model and relatively large confidence intervals. Historically, odd-year returns are significantly harder to predict than even-year. Environmental conditions explored and used in the model affecting the early life survival of the 2011 pink salmon run were generally much better than average, but also hard to quantify because they were outside the ranges often observed. The effects of an unusually large flood in October of 2009 is uncertain; staff review of available literature found no conclusive effects of such flooding on other pink salmon populations. The 2009 indexed escapement estimate of 5.1 million pink salmon is above average.

The predicted wild stock total run is corroborated by ancillary information provided by the pink salmon fry abundance index estimated in Kodiak area harbors in 2010. This index was estimated using the methods of Arnie Shaul, an ADF&G area management biologist on the Alaska Peninsula from 1973 until 2005 who often predicted pink salmon abundance based on prior-year pink fry indices in nearshore waters.

The 2011 KBH pink salmon production is expected to be 7.7 million. The brood stock collection goal is 350,000, yielding a total hatchery harvest projection of 7.4 million. Cost recovery goals for 2011 have not yet been set, but are an estimated 1.0 to 2.0 million will be harvested in the cost recovery fishery. In 2010, 144.4 million fry were released, which was an average amount of juveniles. Average weight of pink salmon fry was 0.70 grams, which was slightly above average and likely due to warm conditions in late April and May.

This forecast level will allow an initial weekly fishing period length of 105 hours (4½ days) for most of the KMA during the initial general pink salmon fisheries (beginning July 6, 2011). By the third week of July, fishing time will likely be extended, by section or district, as true run strengths become known.

M. Birch Foster, Finfish Research Biologist, Kodiak
Drew Aro, Kitoi Bay Hatchery Manager, Afognak

Forecast Area: Kodiak, Spiridon Lake
Species: Sockeye Salmon

Preliminary Forecast of the 2011 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	133	45–222
Escapement Goal	0	
Harvest Estimate	133	45–222

Forecast Methods

The 2011 Spiridon Lake sockeye salmon forecast was prepared by investigating simple linear regression models using 1992 to 2008 outmigration-to-return relationships for three age classes. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Age-1.2, -2.2, and -1.3 fish were predicted from smolt outmigration estimates. All other age classes were estimated by summing the age classes (0.1, 0.2, 1.1, 0.3, 2.1, 3.1, 1.4, 2.3 and 3.2) by return year (1996–2010) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and median age class estimates. When the median return by age class was used, prediction intervals were estimated by calculating the 10th and 90th percentiles of the data. Prediction intervals of 80% for the regression estimates were calculated using the variances of the regression models. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

Sockeye salmon are prevented from returning to Spiridon Lake because barrier falls block upstream migrations in the outlet creek (Telrod Creek). Therefore, all returning adult sockeye salmon are available for harvest, primarily in the Central Section of the Northwest Kodiak District and in the Spiridon Bay Special Harvest Area in Telrod Cove. The 2011 forecast of 133,000 is 43,000 less than the 2010 forecast (176,000) and 41,000 less than the actual 2010 run estimate (174,000). The 2011 run should be mainly age-1.2 (40%) and age-2.2 (34%). Confidence in this forecast is good due to the strength of the regression models. If realized, this run will be about 111,000 less than the recent 10-year average (2001 to 2010) run of 244,000. Peak run timing of Spiridon Lake sockeye salmon through the Westside fishery will be during the month of July.

M. Birch Foster and Mark J. Witteveen, Finfish Research Biologists, Kodiak

Forecast Area: Kodiak, Ayakulik River
Species: Sockeye Salmon

Preliminary Forecast of the 2011 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	713	491–934
Escapement Goal	300	200–400
Harvest Estimate	413	

[a] The escapement estimate and range are the midpoint and range of the combined escapement goals for the early (140,000–280,000) and late runs (60,000–120,000) in 2011.

Forecast Methods

The 2011 Ayakulik River sockeye salmon forecast was prepared primarily by investigating simple linear regression models that use saltwater age class relationships from recent outmigration years. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Age-.2 sockeye salmon were predicted from age-.1 returns using only recent outmigration years (1992 to 2008). The age-.3 sockeye salmon were predicted from age-.1 returns using outmigration years from 1992 to 2007. Prediction intervals of 80% for the regression estimates were calculated using the variances of the regression models. Both age-.1 and -.4 sockeye salmon were predicted by calculating the median return (outmigration years 1992 to present) and prediction intervals were calculated using the 10th and 90th percentiles of the returns. Regression and median estimates were summed to estimate the total Ayakulik River sockeye salmon run for 2011. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% confidence intervals for each age class forecasted.

Forecast Discussion

The 2011 Ayakulik River forecast of 713,000 is 43,000 more than the 2010 forecast (670,000) and about 194,000 more than the actual estimated run of 518,000 in 2010. The 2011 run should be mainly age-.2 (65%) and age-.3 (33%) fish, and would be 370,000 more than the recent 10-year average (2001–2010) and the largest run since 1999. Confidence in the 2011 forecast is good, due to strong regression relationships. The projected harvest (413,000) is based on achieving the midpoint (300,000) for the combined escapement goal ranges of the early and late runs. Escapement goals used are those recommended for 2011, based on a review by ADF&G in 2010.

M. Birch Foster, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Karluk River
Species: Sockeye Salmon

Preliminary Forecast of the 2011 Run

Total Production		Forecast Estimate (thousands)	Forecast Range (thousands)
Early Run	Total Run Estimate	250	110–390
	Escapement Goal [a]	150	110–250
	Harvest Estimate	100	
Late Run	Total Run Estimate	410	315–505
	Escapement Objective [a]	270	170–380
	Harvest Estimate	140	
Total Karluk River System	Total Run Estimate	660	425–895
	Escapement Objective [a]	420	280–630
	Harvest Estimate	240	

[a] The escapement estimates and ranges are the approximate midpoints and the total ranges of escapement goals for the early (110,000–250,000), late (170,000–380,000), and total combined runs in 2011.

Forecast Methods

The forecasts for the 2011 early and late Karluk River sockeye salmon runs were based on available data from 1982 to the present. Simple linear and multiple regressions and Ricker curve relationships were modeled using outmigration year ocean age class relationships, sibling relationships, recent escapements, and zooplankton biomass in Karluk Lake. Each model was assessed with standard diagnostic procedures. Estimates were only used in cases where the model was significant. The minor age classes that could not be estimated with one of these models were estimated using pooled medians. The error structure of each model was used to calculate an 80% prediction interval and the 10th and 90th percentiles of the data were used to calculate the prediction interval of the median estimates.

The number of early run age-.2 sockeye salmon returning in 2011 was predicted based on the prior year return of age-.1 sockeye salmon and the average biomass of zooplankton in Karluk Lake during the two summers prior to outmigration, using a multiple regression relationship. Age-1.3 fish were predicted from their age-1.2 siblings using a simple linear regression relationship. Age-2.3 and -3.3 fish were predicted from their respective age-2.2 and -3.2 siblings using Ricker relationships. The remaining age classes were calculated using their pooled medians.

The number of late-run age-.2 sockeye salmon returning in 2011 was predicted using a multiple regression relationship from the average biomass of zooplankton in Karluk Lake during the two summers prior to outmigration and the average Karluk Lake escapement for the three years prior to outmigration. The age-.3 run was predicted from the prior year run of age-2.2 fish from both

the early and late runs using a Ricker relationship. The rest of the late run was calculated using the pooled medians of age-.1 fish and the pooled medians of all other remaining age classes.

The overall run estimates were calculated by summing each age class estimate. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

The total 2011 sockeye salmon run to the Karluk River is expected to be approximately 660,000. The early run is expected to be approximately 250,000, which is about 218,000 below the recent 10-year average (468,000) and 169,000 above the 2010 run (81,000). The late run is expected to be approximately 410,000, which is 305,000 below the recent 10-year average (714,000) and 94,000 more than the 2010 run (316,000).

The projected harvest estimate for the early run (100,000) is based on achieving the midpoint of the early-run escapement goal range (150,000). The projected harvest estimate for the late run (140,000) is based on achievement of the midpoint of the late-run escapement goal range (270,000). Escapement goals used are those recommended for 2011, based on a review by ADF&G in 2010. The majority of both runs is expected to be age-.2 fish. Our confidence in the forecast is fair.

Mark Witteveen, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Alaiak District, Frazer and Upper Station Rivers
Species: Sockeye Salmon

Preliminary Forecast of the 2011 Run

TOTAL PRODUCTION		Forecast Estimate (thousands)	Forecast Range (thousands)
Early Upper Station River	Total Run Estimate	56	16–97
	Escapement Goal [a]	43	43–93
	Harvest Estimate [c]	13	
Late Upper Station River	Total Run Estimate	348	235–461
	Escapement Goal [b]	186	120–265
	Harvest Estimate [c]	162	
Frazer Lake	Total Run Estimate	329	214–445
	Escapement Goal [d]	148	105–200
	Harvest Estimate [c]	181	
Total Alitak District	Total Run Estimate	734	465–1,003
	Harvest Estimate	357	

[a] The escapement estimate and range for the Upper Station early run are the lower bound and total range of the escapement goal range (43,000–93,000) in 2011; the Alaska Board of Fisheries instituted an optimal escapement goal of 25,000 in 1998.

[b] The escapement estimate and range for the Upper Station late run are the S_{MSY} estimate and range of the escapement goal (120,000–265,000) in 2011.

[c] The harvest of Upper Station bound sockeye salmon is concurrent with the harvest of Frazer Lake bound sockeye salmon and predominantly occurs within the Alitak Bay District.

[d] The escapement estimate is the S_{MSY} (118,000) and escapement goal range (75,000–170,000), plus an additional 30,000 that typically do not ascend the fish pass to Frazer Lake.

Forecast Methods

The 2011 sockeye salmon run to the Alitak District was forecasted with simple linear regression models using saltwater age class relationships by system from recent outmigration years (1998 to 2008). In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Returns of age-.2 sockeye salmon to the Frazer and Upper Station River early runs were predicted from prior year age-.1 returns; for the Upper Station late run, age-.2 returns were predicted based on prior year age-2.1 returns to the nearby Frazer Lake system. For both rivers (all three runs), returns of age-.3 sockeye salmon were predicted from prior age-.2 returns. Prediction intervals of 80% for the regression estimates were calculated using the variances of the regression models. For both rivers (all three runs), age-.1 and age-.4 sockeye salmon were predicted by calculating the median return (post-1998 outmigration year)

and prediction intervals were calculated using the 10th and 90th percentiles of the returns. Regression and median estimates were summed to estimate the total sockeye salmon run for 2011. Overall 80% prediction intervals were calculated as the square root of the sum of squared 80 percent confidence intervals for each age class forecasted.

Forecast Discussion

The 2011 sockeye salmon run to Alitak District is expected to be approximately 734,000, which is approximately 19,000 less than the recent 10-year average run (753,000) and 328,000 more than the 2010 run (425,000). The Upper Station River early run is expected to be approximately 56,000, well below the recent 10-year average (102,000). The Upper Station River late run is expected to be approximately 348,000, above the recent 10-year average (289,000). The Frazer Lake run is expected to be approximately 329,000, just below the recent 10-year average (361,000). The 2011 Alitak District sockeye salmon run should be predominantly age-.2 fish (~85%). Overall, our confidence in the forecast is fair, based on the regression models and the large confidence interval.

The projected harvest estimate of 357,000 is based on achievement of the lower end of the Upper Station early run and mid-point of the Upper Station late run and Frazer Lake escapement goal ranges.

M. Birch Foster, Finfish Research Biologist, Kodiak